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SPACE AGE AGRICULTURE

A Resource Book for Teachers

Division 3, Science

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ALBERTA AGRICULTURE

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INTRODUCTION

Welcome to Space Age Agriculture. In writing this booklet I aimed to provide lessons that you can fit into your everyday teaching. The procedures are intended to be clear and detailed enough that you can use them directly if you wish. At the same time they are only suggestions, and I hope you will feel free to adapt and modify them to suit your needs and your students interests.

This booklet deals particularly with Science at the junior high level. It is part of a three book set. The other Division 3 volumes were prepared for Social Studies and for the Agriculture option. Each book in the set aims to show users that:

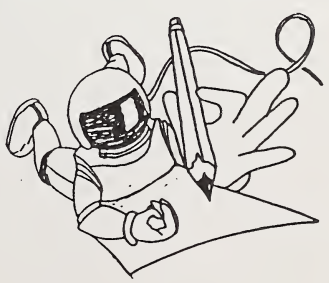
. agriculture is affected by each school subject area, and

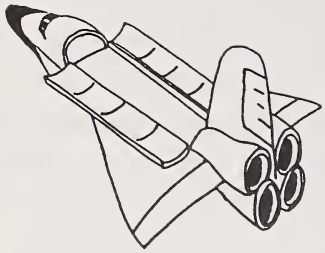
. agriculture is a diverse endeavour that affects even the most urban Albertans.

Agriculture in the Classroom booklets at all grade levels are written to teachers like yourself. Space Age Agriculture is no exception. Throughout the book however there are certain specialty pages that are identified graphically.

Pages marked with this symbol are extended references for you. In classroom explorations you provide ground control, monitoring student effort and guiding students back to earth.

This symbol indicates a student task sheet. Your students act as astronauts exploring the intellectual space and recording their findings.





Pages with this symbol are student resource sheets. They contain information directly useful to the work required by task sheets.

In Space Age Agriculture we have continued to aim for direct links with the Alberta school curriculum. In this case, our focus is the 1987 revision of the Program of Studies for Division 3 Science. Each lesson includes a description of what unit it supports, and what concepts it reinforces within that unit. Feel free to apply the ideas here to topics in other units if that seems appropriate.

This is the pilot edition of Space Age Agriculture. Throughout this year we will be seeking your feedback regarding how lessons work, what modifications you try, where you need expansion or contraction, and any of your other responses. Through this process we hope to produce a resource that any teacher can use effectively in a classroom.

Alberta Agriculture film library or publications library may have some additional relevant resources. We encourage you to write for a publication list and film catalogue. There are available from:

Alberta Agriculture
Publications Office or Film Library
7000 - 113 Street
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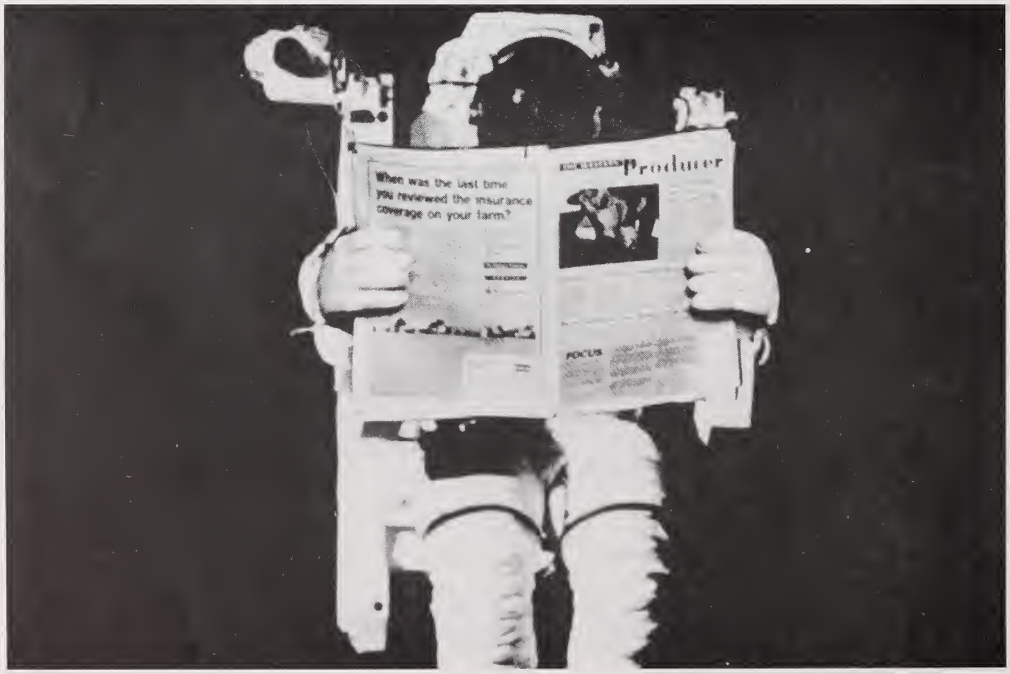


Activity 1

MISSION IMPOSSIBLE

Objective: Students will use science process skills in solving modern agricultural problems which rely on recent advances in biotechnology.

Curriculum Fit: Program Context: The Nature of Science, Technology

Lesson Concepts:
Biotechnology
Applied genetics
Transplants
Transmitters
Problem solving
Remote sensing

Agricultural Concepts:
Technology and capital intensity
Diversity of agriculture

Cognitive Level: Application

Materials Required:
Problems (attached)
Problem-solving format (attached)

Time Required: 20 minutes per item

BACKGROUND - To the Teacher

Scientists use a problem-solving approach to develop state of the art technology. Biotechnology involves the use in industry of artificially altered living organisms or their components (e.g. hormones). Powerful new genetic technologies which have been discovered and applied to agriculture play a major role in improving the speed, efficiency, and productivity of plants and livestock.

In terms of your Program of Studies for Division III Science, this lesson addresses Program Context. Students will use a scientific approach to solve some seemingly unsolvable problems. The enclosed format leads students to use such science process skills as interpreting data, formulating models, inferring and communicating. These help the student to understand the impact of biotechnology on the agricultural industry.

Any of the problems can stand on its own. Therefore you can use a version of this lesson whenever your students have some time available to devote to creative thought and to investigating the nature of modern technology. As an alternative, after you have used this lesson once with the whole class, you can set it up as a work station for students who finish other work ahead of time.

Some students may be able to write new problem and solution card sets based on newspaper or magazine articles about new developments in agriculture.

PROCEDURE

Part 1

Preparation:

1. Make about 10 copies of the "Problem Solving Format" (attached).
2. Photocopy the Problem-Solution pages and cut out the individual cards. NOTE: Pre-read the cards in case your students will need some background introduction.
3. If you are going to use this lesson frequently or set it up as a permanent work station you should mount each problem and solution step on an index card and plasticise them.
4. Mix the solution step cards up so they are at random.

Part 2

Introduction:

5. Divide your class into groups of 3.

6. Give each group a copy of the Problem Solving Format and explain that they are going to use this format to solve some modern agricultural problems.

Part 3

The Activity:

7. Have someone from each group choose a problem card.

8. Spread the solution step cards around the room while the groups consider their task.

9. Allow the students 5 minutes to find 4 cards that produce a logical solution to their problem.

Part 4

Conclusion:

10. Have one elected spokesperson from each group present their group's solution to the class.

NOTE: You can insert a single problem into any class, or you can devote an entire class to solving problems.

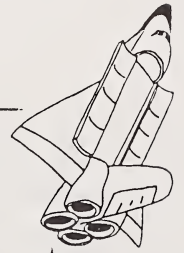
RELATED ACTIVITIES

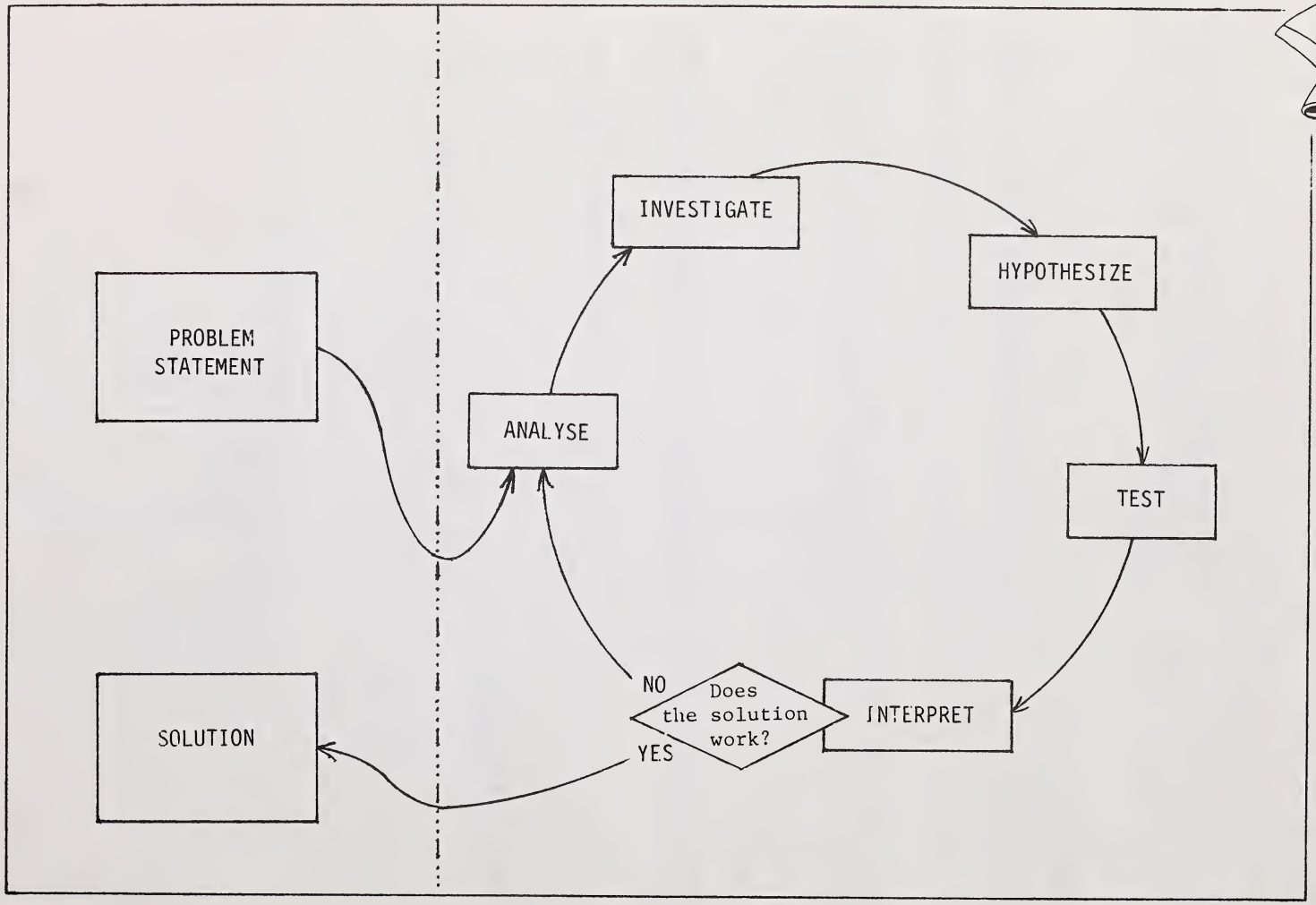
Visit or invite a guest speaker from a private or government laboratory that is involved in biotechnical research.

OUTSIDE ACTIVITIES

Improving the Odds (video tape), Alberta Agriculture.

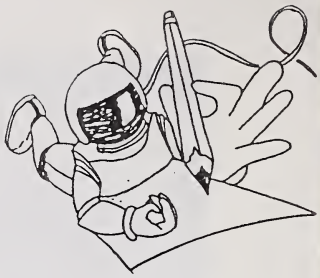
PROBLEM SOLVING FORMAT





Agricultural research - a field test plot.

Agricultural research - hand pollinating plants.



PROBLEM

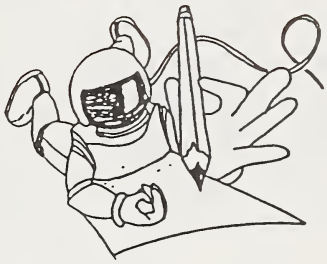
Good day, Agent AgSci.

Your assignment is to deliver 1000 head of beef cattle to Australia in two days. You must remain with them at all times, and transport them in two pieces of aircraft carry-on luggage. Thank you for having volunteered.

T.

RECOVERY, STORAGE AND TRANSFER OF EMBRYOS

1. Fertilized ova (calf embryos) can be removed from a mother cow and kept alive in a laboratory dish.	2. Collected embryos can be stored indefinitely by freezing them.
3. Frozen embryos can be transported in an insulated case kept cold with dry ice.	4. A veterinarian can implant a calf embryo into any mature cow.



PROBLEM

Good day, Agent AgSci.

Your assignment today is to develop a better feed for Alberta dairy cattle. The feed must be as cheap as farmers use now, but cows must produce more milk when they eat it.

Thank you for having volunteered.

T.

PLANT BREEDING FOR LOWER HEAT REQUIREMENTS

1. Field corn yields more tonnes per hectare of silage than typical Alberta feed grains like barley. Furthermore, each kilogram of corn silage has more energy than barley or other hay silage.	2. Most varieties of field corn can only grow where the growing season has 2800 heat units each year. Central Alberta's summer has about 2000 heat units.
3. Through selective breeding scientists have developed a type of corn, called Pioneer 3995, that will mature with only 2150 heat units per summer.	4. Even though corn needs more fertilizer and herbicide than barley, it returns about $280 more feed per hectare planted to the farmer.

PROBLEM

Good day, Agent AgSci.

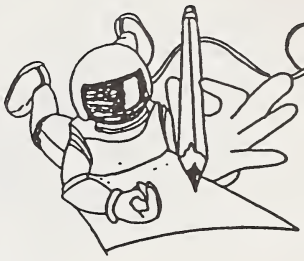
Your assignment today is to transport 10,000 artificially cloned tomato seedlings to Lyons, France. These tissue cultures are very fragile and must be kept moist throughout the trip.

Thank you for having volunteered.

T.

ARTIFICIAL SEED CAPSULE

1. To cushion the seedling cultures and protect them from drying, you need a coating that will contain a water supply but can be dissolved from the outside.	2. Water can be prevented from dissolving materials by trapping it in a gel. This is a material in which micro-droplets of water are surrounded by molecules of some other substance. It gets its name from gelatin which is the best known example.
3. Suspend the seedling culture in a gel; surround the gel with a water-soluble plastic coating; transport the resulting artificial seeds in any dry box.	4. When the artificial seeds are planted, soil water will disolve the plastic and dilute the gel. This will free the seedling culture which can begin to grow.



PROBLEM

Good day, Agent AgSci.

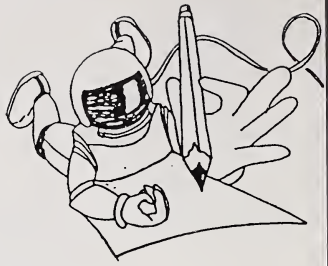
Your new assignment is to help an Alberta farmer keep track of crop conditions on 17 widely separated quarter-sections. Information must be visual and relayed to him at his farm headquarters.

Thank you for having volunteered.

T.

REMOTE SENSING

1. The resource satellite Landsat circles the earth several times each day, and gathers data based on how much light is reflected by the earth's surface.	2. From this reflection, Landsat can record topography, local weather patterns, surface soil color, soil moisture, and vegetation.
3. The information Landsat gathers is stored and transmitted in computer language, but it is commonly displayed as a map with different conditions shown by different colors.	4. A series of Landsat recordings allow a farmer to assess the conditions, trends and rates of change for either crops or pastures.



PROBLEM

Good day, Agent AgSci.

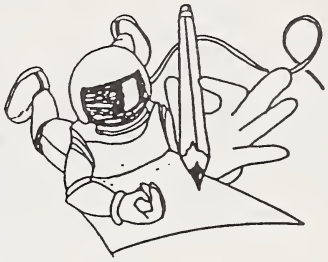
Your assignment today is to help a rancher trace the movements of a herd of cattle that pasture on open range in South-central Alberta. The information must be available at the ranch office, anytime of the day or night, and as soon as it is gathered.

Thank you for having volunteered.

T.

BIOMEDICAL TELEMETRY RADIO WAVES TRANSMITTER

1. Scientists have developed a tiny radio transmitter (1 cm in diameter, 3 cm long) that, if implanted in a cow, will emit a signal every 5 minutes for 5 - 10 years.	2. The signal from this transmitter can be picked up by an antenna on a hilltop, relayed to a receiver and decoded by a computer at the ranch office.
3. This radio/computer system can gather and separate information on the location, health and identity of up to 1000 head of cattle.	4. One of these transmitters can be fed to a cow like a pill, and once swallowed will remain in the animal's first stomach as long as it lives.



PROBLEM

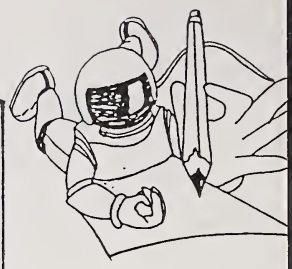
Your assignment today is to make it possible for a sandwich packager to extend the time his product can be stored at room temperature without going stale.

Thank you for having volunteered.

T.

VACUUM PACKAGING

1. Food spoils when oxygen inside a package combines with fatty products in the food to produce humidity.	2. Freezing, cooking, drying and salting all prevent spoilage, but all cause changes in the flavor or texture of the food.
3. Pumping the air out of a package and sealing it under vacuum conditions will prolong a food's shelf life while protecting its flavor. Gas-proof packaging materials are required.	4. Oxygen can be displaced by pumping nitrogen or carbon dioxide gas into the package. Either gas will stop the spoiling process, while also providing enough inside pressure to prevent air from leaking back in.



PROBLEM

Good day, Agent AgSci.

Your assignment is to find a way to determine whether cows are pregnant or not. Your method must work in the first month of their pregnancy.

Thank you for having volunteered.

T.

ULTRASOUND WAVE TRANSMITTER

1. An ultrasound transmitter gives off high frequency sound waves. The waves travel in constant patterns until they reach a change in density. A density change reflects waves back toward their source.	2. When a cow is pregnant, body fluids accumulate in her reproductive organs so that their density increases.
3. An ultrasound machine that works like airport radar and submarine sonar sending out waves and reading their echoes, should be able to detect pregnancy by identifying the fluid buildup that goes with it.	4. An ultrasound transmitter must directly touch the skin with no air gap. Shave the hair from a patch of abdominal skin, coat the transponder with mineral oil or petroleum jelly and hold it firmly in place.

PROBLEM

Good day, Agent AgSci.

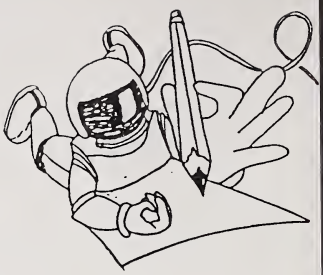
Your assignment today is to raise the milk output of healthy well fed dairy cows by 30%. This increase must occur within a month.

Thank you for having volunteered.

T.

RAISING A COW'S MILK PRODUCTION

1. When a cow has a calf, she begins to produce a hormone called somatotropin. Somatotropin continues as long as she is milked.	2. In all mammals, the hormone somatotropin causes new mothers to produce milk for their offspring.
3. Scientists can gather somatotropin from the blood of cows with new calves, and may soon be able to make it in laboratories.	4. If a milking cow receives extra somatotropin by injection, her production of milk will increase. Laboratory tests have produced increases as large as 30%.



PROBLEM

Good day, Agent AgSci.

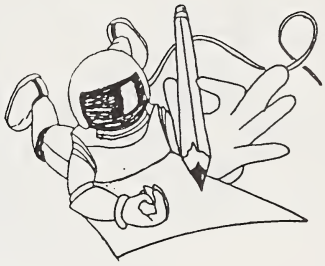
A part-time farmer needs your help. Your assignment is to ensure that his 50 ewes (female sheep) all have lambs in the same month next year.

Thank you for having volunteered.

T.

SYNCHRONIZING LAMBING

1. Ewes (female sheep) will only mate with rams during a condition called estrus (or heat).	2. Estrus is started when the ewe begins to produce a hormone (body chemical) called PGF2.
3. If a ewe is injected with synthetic PGF2, she will enter estrus within 48 hours.	4. Lambs develop for 145 days between fertilization and birth.



PROBLEM

Good day, Agent AgSci.

Your assignment today is to obtain 8 genetically identical bulls for an Alberta farmer. He believes that having the same genes will make the bulls similar in their behaviour, therefore more predictable and therefore safer.

Thank you for having volunteered.

T.

EMBRYO SEPARATION

1. In the first part of its life, an embryo grows by having each cell form an exact duplicate of itself. Thus one cell becomes two, those two become four, those four become eight and so on.	2. Up to the 8-cell stage, cells that are separated from each other will develop as if they were separately fertilized ova.
3. Scientists have produced as many as four animals with identical genes from splitting a single 8-cell embryo.	4. Embryos cultured in a lab can be implanted into a cow which then acts as a surrogate mother.

PROBLEM

Good day, Agent AgSci.

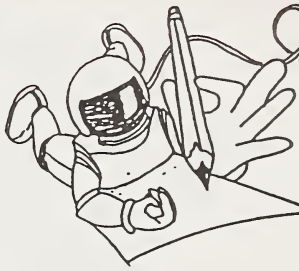
Alberta's wheat farmers cannot pay their fertilizer bills. Your assignment is to identify a way of increasing the supply of soil nitrogen to plants without using nitrogen fertilizer.

Thank you for having volunteered.

T.

PLANT BREEDING AND GENE TRANSFER

1. Atmospheric nitrogen forms 78% of normal air, but is in a form that plants cannot use. Some soil organisms can convert atmosphere nitrogen into a form useful to plants.	2. Alfalfa, peas, clover and other legume plants form root nodules in which nitrogen-fixing bacteria called Rhizobium can live.
3. Adding Rhizobium bacteria to alfalfa pays back 30 times as well as adding nitrogen fertilizer.	4. If plant-breeding scientists can transfer the "root nodule" gene from alfalfa (or any of the legume family) into wheat embryos, then wheat plants could support their own Rhizobium colonies.



PROBLEM

Good day, Agent AgSci.

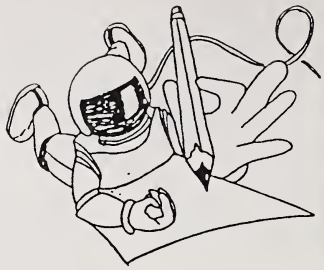
Your assignment for today is to arrange for some cattle to grow to full size without having their meat change from veal to beef.

Thank you for having volunteered.

T.

INCREASING YIELD OF VEAL CALVES

1. The muscles of calves differ internally from the muscles in adult cattle. Calves' muscles yield veal, adult cattle muscles yield beef. Normally the muscles become adult in structure by the time a calf weighs 90 kg.	2. Some Piedmontese breed cattle have a gene called "double muscle" that causes their calves to be much larger than other breeds when their muscles change from veal-type to beef-type.
3. Scientists can produce animals with four parents instead of two by fusing two embryos together. The resulting animal is called a chimera (the "ch" is pronounced "k".	4. The chimera from fusing a Piedmontese embryo with a dairy breed embryo will remain calf-like in its muscle structure until it weighs 350 kg.



PROBLEM

Good day. Agent AgSci.

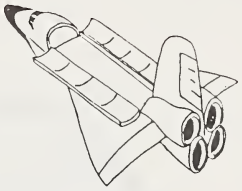
Your assignment is to ensure that next year Alberta's All Round Champion Cow (the AARCC) has 10 calves in the same month.

Thank you for having volunteered.

T.

SUPEROVULATION OF COWS

1. The release of egg cells in cows is controlled by a hormone (i.e. a body chemical) called FSH.	2. A cow can be made to release several egg cells instead of her normal one by an injection of extra FSH.
3. A veterinarian can collect egg cells from a cow, fertilize them artificially and implant them into any mature cow.	4. Calves are born 275-290 days after fertilization.



GLOSSARY: TECHNICAL TERMS IN THIS LESSON

artificial insemination - a process in which semen from a male animal is collected medically, and may be stored or transported before being injected into a female of the same species.

chimera - an offspring with four parents produced by the fusion of two living embryos.

clone - a living thing that is grown from normal body cells of its parent. All clones of one parent are genetically identical to it and to each other.

dry ice - a solid formed by freezing carbon dioxide. It has a temperature of -78.5° and it changes directly to a gas at all ordinary air pressures.

embryo - an animal in the earliest stages of development, from fertilization until the advanced.

estrus - the time following ovulation during which a female animal is fertile and will accept an attempt to mate.

gel - the semi-solid form of a mixture of water and some other large molecule, e.g. gelatin. Heating, diluting and salting will convert these mixtures from gels to a fluid called a sol.

gene - a chemical unit in each cell of a living thing that controls the inheritance of its hereditary traits.

genetically identical - having the same set of genes as another living thing. This occurs in identical twins and in clones.

hormone - a chemical produced in certain body cells that circulates in the blood (or the sap of plants) and activates cells that are distant from its origin.

legume - any plant of the large family that includes the peas, beans, and clovers.

nodule - a small mass of rounded or irregular shape; in plants, a swelling on the root that contains bacteria.

organism - a general term for living things, used to include plants, animals and microbes.

ova - plural form of ovum, a female reproductive cell; an egg.

ovulation - the release of a mature ovum from the ovary so that it may be fertilized.

pituitary gland - a small oval organ at the base of the brain which produce a variety of secretions that control how other organs function.

surrogate - anything that acts in place of another. (Substitute)

tissue culture - a group of similar cells removed from the organism in which it developed and grown in an artificial laboratory medium.

Agricultural research - chemical testing.

Activity 2

SO, WHO CARES WHEN IT RAINS

Objective: Students will observe how a growing cereal grain plant responds to different watering regimes.

Curriculum Fit: Grade 7, Topic 1: Characteristics of Living Things

Lesson Concepts: Response of an organism to stimuli

Agriculture Concepts: Importance of soil and water

Cognitive Level: Application, Synthesis, Evaluation

Materials Required:
Planting mix in trays or pots
Distilled or aged water
Fluid measuring apparatus
Seeds of wheat, barley or oats

Time Required: 20 minutes to set up experiment

one minute every third day to water plants and record observations

BACKGROUND - To the Teacher

Responsiveness to stimuli is a basic characteristic of living things. Therefore it is a major field of study within the life sciences. It is also important at the production level of agriculture.

One key to a farmer's success is how well his crops respond to the stimuli they receive. In some cases, like egg production, pork production, or greenhouse production, the farmer can exert extensive control over what stimuli affect his crop. For other types of farming, like field crop production or cattle ranching, the farmer is only able to choose breeds or individuals that will likely respond productively to the stimuli they are most likely to receive.

In this lesson, your students will see how germinating grains respond to different amounts and schedules of watering. This should help them to understand why spring weather or water supply is so important to farmers.

PROCEDURE

Part 1

Preparation:

1. Your students will work in groups of 4 or 5. Decide on the number of groups you will have and who will be in each.
2. For each group fill three trays or pots with planting mix.
3. Obtain a supply of seeds of one grain type and divide it so that each group will receive a similar amount.

Part 2

Introduction:

4. Explain the set up and procedure of the experiment and tell the students that its results should show why rainfall patterns matter to farmers.
5. Assign the students to their working groups.

Part 3

The Activity:

6. Have each group water the soil in one tray until it is saturated and draining from the bottom. This is Tray # 1. Do not water the other trays at this time.

7. Have students divide their seed grain into three sets.

8. When the watered tray stops dripping have students spread their seeds over the soil, rake the soil lightly to cover the seeds and lightly press the soil again.

9. Have students water a second tray until the soil surface is wet, but not until water begins to drain from the bottom. This is Tray # 2.

10. Each group must arrange to water Tray #1 and Tray #2 every third day, and to record changes in the trays daily. Watering should be enough to wet the top .5 mm of soil only.

Part 4

Conclusion

11. After two weeks students should be able to report:

    a) which grain sample germinated fastest.
    b) which grain sample produced the most plants.

12. Once the initial two weeks is finished, have students stop watering but continue to record changes in each tray.

DISCUSSION QUESTIONS

1. Which watering regime was most favorable to the seeded grain?

2. Based on class results, speculate on the importance to grain farmers of

    a) soil moisture from melting snow.
    b) spring rains.
    c) summer rains.

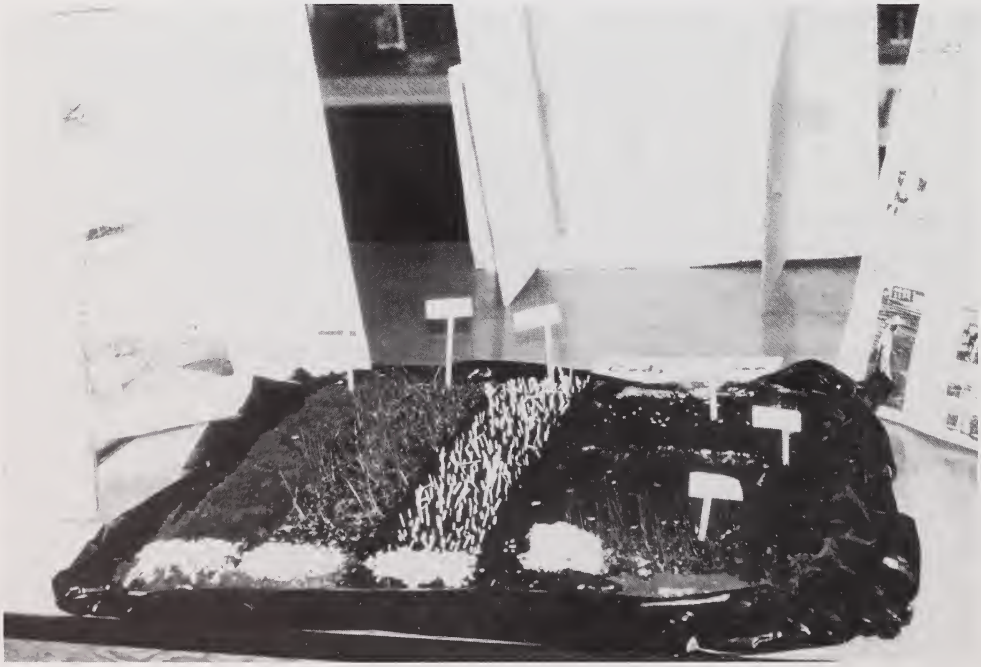
3. What other weather factors are important to farmers?

4. Do different kinds of farmers need different kinds of weather?

RELATED ACTIVITIES

1. Interview a farm owner, implement dealer, or district agriculture about the ideal weather for farms in your area.

Checking results of this year's soil treatments.



An experiment to show plant response to fertilizer.

H.T. Coutts School 1987 Agricultural Fair. Claresholm, Alberta.

Activity 3

WHY PASTEURIZE MILK

Objectives:

Students will determine the effect of pasteurization on microbial populations and shelf like of milk.

Curriculum Fit:

Grade 7, Topic 5: Microscopic Systems

Lesson Concepts:

Role of micro-organisms in food spoilage

Technologies for preparing, preserving and protecting human food

Safety standards for preparing and handling food.

Agriculture Concepts:

Technology and capital intensity
Production, processing and distribution system

Cognitive Level:

Application, Analysis

Materials Required:

- unpasteurized milk
- 1 ml glass pipettes with 1/10 ml graduations (60 autoclavable or 200 disposable)
- enamel cooking pot
- bunsen burner
- 50 pre-poured nutrient agar in petri dishes
- sterilized test tubes and test tube holder
- pH meter and pH 4 and pH 7 solutions to calibrate pH meter
- 10 glass spreaders and 95% alcohol solution to sterilize spreader
- 1 l. boiled water or 0.1% peptone solution adjusted to pH 7
- thermometer

Time Required:

2 - 3 lessons

BACKGROUND

The dairy is a modern processing plant where milk is tested for quality, processed and packaged before delivery to stores. The milk the tank truck delivers to the dairy is called raw milk. It has not yet been pasteurized and may contain harmful bacteria. Some bacteria found in raw milk may cause disease and illness in people who drink it. Other bacteria cause milk to spoil, reducing the time it can be stored. Therefore, all milk for sale in stores has been pasteurized.

Louis Pasteur, a famous French scientist, discovered long ago that heating milk to 63°C for 30 minutes, then quickly cooling it to 4°C would kill harmful bacteria without changing the nutrient value of the milk. This process became known as pasteurization.

Today a much faster process is used by the dairies. This process is called High Temperature Short Time pasteurization (HTST) and involves heating the milk to a minimum of 72° for 16 seconds.

There is an even faster process which produces milk that needs no refrigeration - it is sold by grocery stores in boxes stored on the shelf. This special method of pasteurization is called Ultra High Temperature (UHT) pasteurization. In this process, the milk is heated to a minimum of 130°C for 1 second then quickly cooled to 2°C. Because of this higher heat treatment, the milk is almost sterilized and doesn't need refrigeration until it has been opened. UHT milk has the longest shelf life.

In this lesson, students will learn what pasteurization is, what pasteurization does, and the effect pasteurization has on the bacteria count in milk and on shelf life. If you have access to a pH meter, you can show the effects of bacteria on the quality of pasteurized milk. Because milk is a good buffer, it takes a long time for the pH to change, even in an unpasteurized milk sample. By leaving the milk at room temperature for 48 - 72 hours, however, the deterioration process increases rapidly and students should be able to see that the unpasteurized sample has undergone a greater drop in pH than the pasteurized sample. This more extreme development of acid conditions indicates greater bacterial action.

PROCEDURE

Part 1

Demonstration:

1. Set two identical, cleaned beakers at the front of the class and mark them 1 and 2.
2. Add 250 ml of pasteurized milk to beaker 1 and 250 ml of unpasteurized milk to beaker 2.
3. Test each milk sample for pH and record results as STARTING pH.
4. Explain to the students that the two samples will be left at room temperature for the next three days, and that you will test for pH at 24, 48, and 72 hours.
5. Ask your students to predict the results.

Part 2

Preparation:

6. Divide the class into working groups of three.
7. Set up the pasteurization apparatus: either a large pressure cooker or a water bath with several wire test tube racks.
8. Boil 1 l water or prepare 1 l of 0.1% peptone solution for students to use diluting milk.
9. Prepare four petri dishes with sterile nutrient agar for each working group.

Part 3

Introduction:

10. Explain pasteurization briefly.
11. Describe the experiment and its meaning.
12. Rearrange the students into their work groups and distribute the group apparatus.

Part 4

Student Experiment:

The students will be pasteurizing a sample of raw milk and comparing bacterial growth in this pasteurized milk with raw milk.

Identification:

13. Each group must label their test tubes and petri dishes with their group name. They should also number their petri dishes 1 - 4.

14. Add 5 ml of raw milk to each of two test tubes.

Pasteurization:

15. Place one test tube in the pasteuruizing apparatus. (Use either a pressure cooker at 15 psi for 15 minutes or an open water bath at 63°C for 30 minutes.)

Dilution:

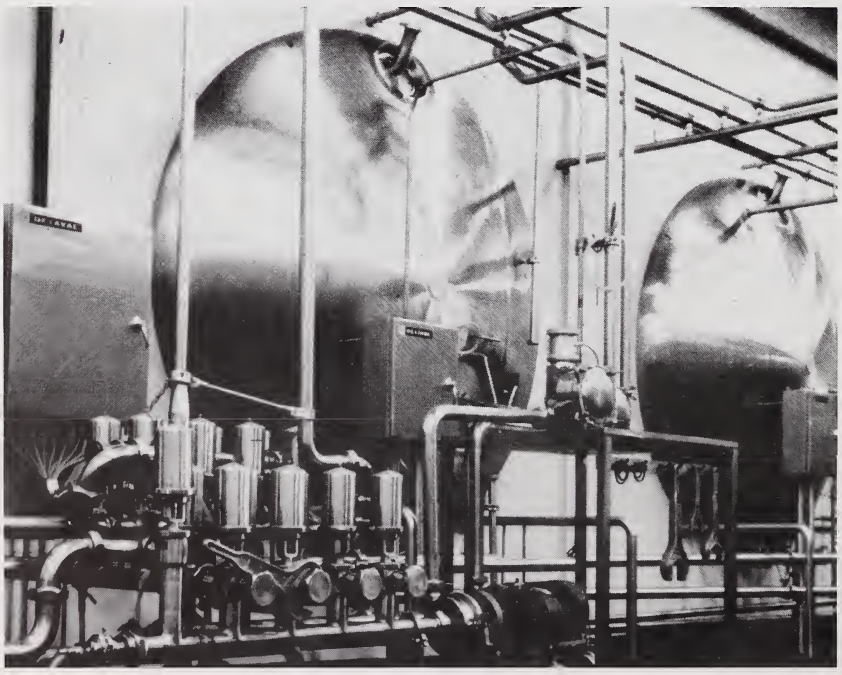
16. Number two beakers; add 99 ml of boiled water to #1 and 9 ml of boiled water to #2.

17. With a sterile graduated pipette, draw 1 ml of raw milk from the second test tube and add it to Beaker #1. Gently blow through the pipette to force out the last drop of milk.

18. Shake Beaker #1 well to mix solution.

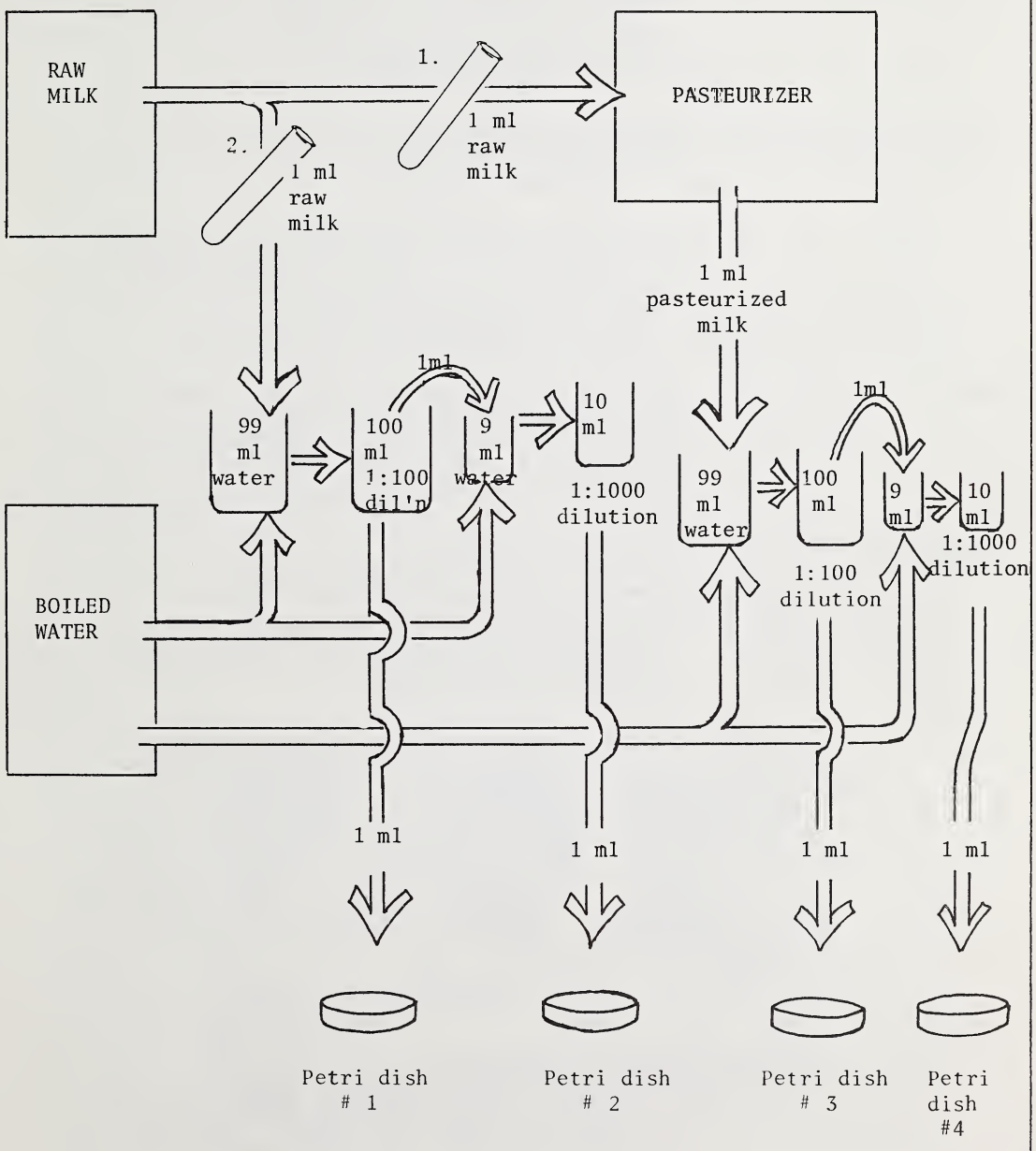
19. Use a new pipette to remove 1 ml of the diluted milk in Beaker #1 and add it to Beaker #2.

NOTE: This procedure is summarized in the diagram that follows.



Industrial-size pasteurizing vats.

DILUTION PROCEDURE



Transfer and Spreading:

20. Use another new pipette to transfer 1 ml of the 1:100 dilution liquid to petri dish #1.
    * Lift the petri dish cover just high enough to insert the pipette.
    * Hold the pipette at a 45° angle, touching the dish side above the agar.
    * Do not blow on the pipette.
    * Close dish cover immediately.

21. Repeat the steps immediately above with a fourth pipette to transfer 1 ml of the 1:1000 fluid to petri dish #3.

22. Use a sterilized glass spreader to spread the diluted milk evenly across the agar surface.
    * Rinse the spreader in 95% alcohol solution after each culture is spread.
    * Close lid immediately after spreading.

Repetition:

23. When the pasteurized milk is ready, repeat the dilution, transfer and spreading procedure for the cooled, pasteurized milk. Use beakers #3 and #4, dishes #3 and #4, and sterile pipettes at each stage.

Incubation:

24. Invert petri dishes.

25. Leave at room temperature for 72 hours.

26. On the third day test the pH of the two milk samples you established on Day 1. Have the students record results.

27. On Day 4, students should inspect their petri dishes (48 hour count). Have them hold each one up to a light source and count all the opaque spots, even those that are only pinpoint size. This count should be repeated the next day (72 hour count), but if that is impossible then put the petri dishes in a refrigerator at about 4°C to slow development until colonies can be counted.

Part 5

Conclusion:

28. Compile the results of the plate counts. Compare the average counts of pasteurized and raw samples at each time period. How does pasteurization affect bacteria growth in milk?

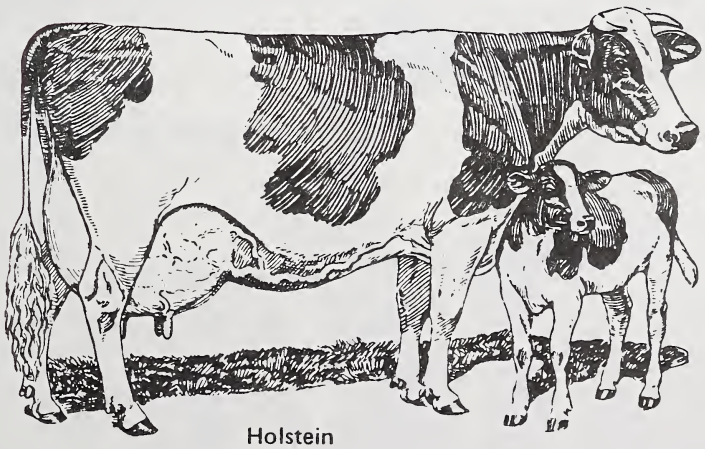
29. Based on the demonstration, how does pasteurization affect souring of milk?

DISCUSSION QUESTIONS

1. Define pasteurization/sterilization.
2. In what way(s) are bacteria harmful/beneficial to us?
3. Why does UHT milk not require refrigeration when stored?
4. Is there a difference in taste between normally pasterurized (HTST) milk and UHT milk? (perform taste test) Why?
5. What factors influence the souring of milk?
6. What is the total count of bacteria in the original sample of raw milk (undiluted) if you counted 200 colonies on the plate containing 0.001 ml of the sample of raw milk?
7. Why must we be so careful to use clean glassware when transferring solutions?

RELATED ACTIVITIES

1. Discover more about the work of Louis Pasteur.
2. Invite a speaker from the Board of Health to talk about pasteurization and other food purifying practices.



Holstein

LAIT ÉCRÉMÉ EN POUDRE
INSTANTANÉ
Carnation
SKIM MILK
Nu-Maid
YOGOURT
Nu-Maid
Sour Cream
500 mℓ
Nu-Maid
Cre. med
Cottage
Cheese
SKIM
Alpha
EVAPORATED MILK
LAIT ÉVAPORÉ
CHOCOLATE
Nu Maid
CHOCOLATE
CEREAL
CREAM
Nu-Maid
WHIPPING
CREAM

Activity 4

MOTHERS OF INVENTION

Objective: Students will design, construct, test, and market a simple agricultural machine.

Curriculum Fit: Grade 8, Topic 2: Energy and Machines

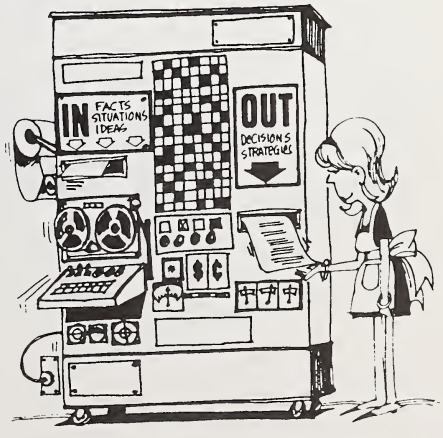
Lesson Concepts:
Applications of mechanical systems
- Inventing a device that makes efficient use of energy.
- Technology is concerned with the solution of practical problems.

Agricultural Concepts:
Technology and capital intensity
Production, processing and distribution system

Cognitive Level: Application, Synthesis, Evaluation

Materials Required: Frozen corn on the cob (1 cob per student or 1 per group)

Time Required:
1 - 3 lessons
Additional student independent time might be needed.



BACKGROUND

Machines are devices for doing work. Modern food producers and processors use many large and complex machines to keep up with global food requirements. To develop these machines the agricultural industry relies on scientific research and technology.

Past agricultural inventions arose out of a need to solve problems and usually involved much trial and error. History shows that solving one problem often leads to new problems. Therefore, criteria beyond speeding up a job must be made for an invention to be accepted. Some of these criteria cannot be satisfied. A successful invention is one which meets the most criteria, including those that are of major concern at the time.

In this lesson students are to design, construct, test, and market a simple agricultural machine. This experience will require them to act as scientists, experiencing the process of inventing. As they work, your students must keep in mind the criteria or guidelines necessary for their invention to be accepted. They may discover that not all of these criteria can be met completely.

This activity will probably be most successful if you introduce it when your students have just finished their unit on the six simple machines: levers, pulleys, wheel and axle assemblies, inclined planes, wedge and screws. They can include any combination of these to multiply the forces acting on the corn.

PROCEDURE

Part 1

Introduction:

1. Ask students for examples of past inventions. Do these inventions have elements in common?
2. Have the class make a list of criteria which an invention must meet.
3. Once the class has developed a set of criteria for evaluation you can show the corn cobs and present the problem: To invent a machine that will get the kernels off the cob without damaging them.

Part 2

The Activity:

4. Students can work alone or in groups preparing a "blueprint" (eg. sketches of corn and "de-kernelizer", materials needed, procedures in construction invention, testing methods, etc.)

5 Once the students have developed a workable idea, they should construct their corn "de-kernelizer" for display to the class.

Part 3

Conclusion:

6. When all students (or groups) have demonstrated their machines, they should each rate all entries against the criteria established earlier.

DISCUSSION QUESTIONS

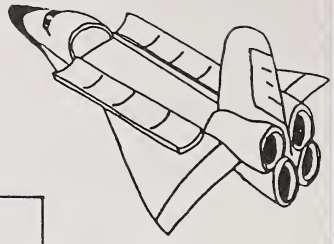
1. How do inventions come about?
2. Does the invention meet all, some, or any of the list of criteria?
3. Do some criteria conflict with others?
4. Which inventions used the principles you were taught in the Machines and Mechanics Units? How?
5. Could an invention be improved? How?
6. Do inventions ever change over time? Why? Examples?

RELATED ACTIVITIES

Invent an agricultural device which will

- draw milk out of a rubber glove
- automatically "irrigate" a flower pot at specified time durations
- de-skin a potato leaving no marks
- thresh wheat

RATE YOUR INVENTION WITH THESE CRITERIA



Ease of operation

Safety

Manpower needed

Adaptability to surroundings

Efficiency (time requirements)

Appearance

Availability

Cost

Noise control

Waste control

Damage to surroundings

Durability

Activity 5

THE HUMAN INCINERATOR

Objective: Students identify all of the food and non-food substances that they ingest in a week and trace them back to their original sources. They then develop a web to display these results.

Curriculum Fit: Grade 8, Topic 3: Consumer Product Testing

Lesson Concepts: Consumer product characteristics and composition
Science inquiry skills

Agricultural Concepts: Technology and capital intensity
Production, processing and distribution system

Cognitive Level: Analysis

Materials Required: Large copy of the Human Incinerator Ingestion Web

Time Required: 3 - 5 lessons

BACKGROUND

Not long ago people knew that what they were eating originated, either directory or indirectly, from a plant. Nowadays, if an item does originate from a plant, it usually goes through many changes before reaching us. To the food market, processed food means better looking, smelling, and tasting food and a longer shelf life; all of which means greater profitability. To the consumers, processed food offers convenience and speed in preparation.

There are also fabricated foods that weren't picked from any plant - foods that weren't just changed by processing but created by it. By fabricated foods, the industry means items made from cotton seed, alfalfa protein, peanut flour, triticale and algae; dairy substitutes instead of dairy products; dehydrated potatoes instead of raw potatoes and vegetable protein meat analogs instead of meat cut. It is becoming more and more difficult to trace "food" back to its source.

Throughout their work on this lesson, students will first come to recognise the variety of things that they ingest. As they continue, they will see the sources of these substances and the processes by which the substances reach them.

PROCEDURE

Part 1

Preparation:

1. One week prior to this lesson, hand out a copy of the Human Incinerator Ingestion Web and have each student fill out the branches with all that they ingest throughout the week.

Part 2

Introduction:

2. Using the overhead projector or workboard, draw a composite Ingestion Web, filling out the branches using food and non-food substances the students have ingested over the past week.

Part 3

The Activity:

3. Classify a few substances according to the four basic food groups. Some substances, will not fit in any of the food groups. Leave these substances for the students to research on their own later.

4. Identify the ingredients in a few substances ingested. This again will involve research for the more difficult substances and students will do this later.

5. Identify the origin of a few substances and determine whether it is a natural food or a non-food, fabricated food or non-food, enriched food or a food which has been given additives. You will have to define each of these categories and supply each student with a copy of the Human Incinerators Terms. They will use the definitions to categorize a substance they choose from the classroom web.

6. Have the students choose one substance from the classroom web which has not been classified and create a chain for it showing the steps involved from its origin to its ultimate processor . . . themselves. They might have to use the library at this point.

7. Have the students complete the attached Human Incinerator Table.

Part 4

Conclusion:

8. Using the overhead projector or blackboard, complete the Human Incinerator Table using the food and non-food substances your students chose in step 6.

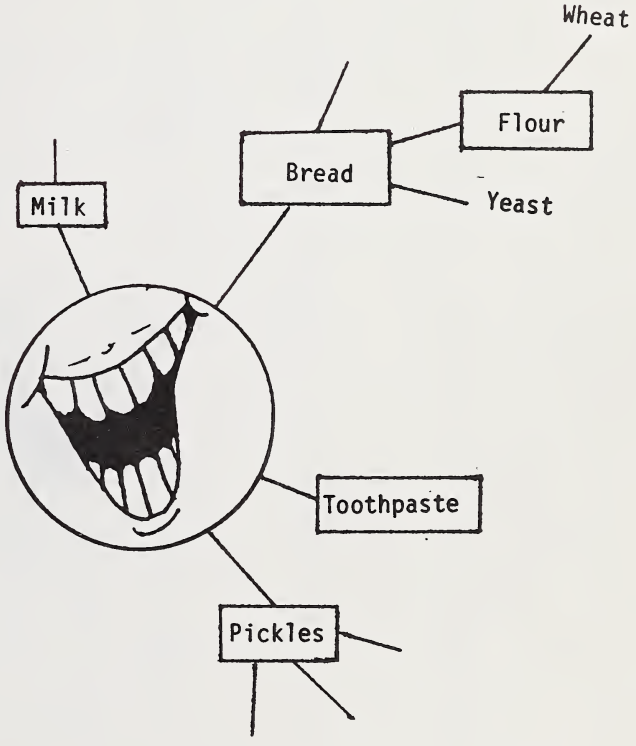
DISCUSSION QUESTIONS

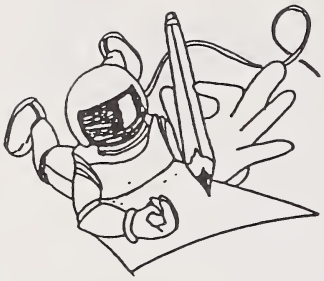
1. What is the original source of the substance (i.e. land, ocean, lab.)?
2. If land is a primary source, did the item come from a domesticated plant/animal or a wild plant/animal?
3. What are some of the consequences of domestication (eg. on prices, energy use, plant and animals, environment)?
4. How many steps did the item undergo before reaching your mouth?
5. Did the item come from Alberta? Canada? Outside of Canada?
6. If the item came from Alberta, is it grown locally?
7. What item cost more, one from the land, ocean or lab? Why?
8. Did the item come directly from a plant or an animal? If not, then where did it come from?
9. What is the purpose for food processing?
10. What is the difference between food additives and food enrichment?
11. Should food be processed? What are the pros/cons?

RELATED ACTIVITIES

1. Deadly Links from Project Wild using a food chain with humans as the final link.
2. Have students bring food labels and list some additives in common foods.

Example of Human Incinerator Ingestion Web



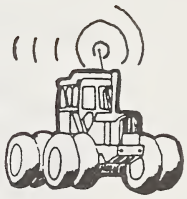


HUMAN INCINERATOR INGESTION WEB

HUMAN INCINERATOR TABLE

FOOD OR NON-FOOD	BASIC FOOD GROUP	INGREDIENTS	ORIGIN	CATEGORY	STEPS INVOLVED

Activity 6



CONSUMER REPORT

Objective: Students will perform various quality tests on different brands of bread in order to write a "consumer report".

Curriculum Fit: Grade 8, Topic 3: Consumer Product Testing

Lesson Concepts: Product testing

Standards for product composition, packaging, labelling and advertizing.

Agriculture Concepts: Technology and capital intensity
Production, processing and distribution system

Cognitive Level: Analysis, Evaluation, Synthesis

Materials Required: Main Activity

- loaves of bread from as many different companies as possible
- weight scale
- height scale
- kitchen knife

Optional Activity

- bread samples
- distilled water
- 6M sulfuric acid
- 45% ethanol
- 250 ml glass beakers

Time Required: 1 - 2 lessons

BACKGROUND

What goes into bread? Ingredients include flour (54%), water (37%), yeast (3%), whey milk powder (2%), shortening (1%), salt (1%), sugar (1%), vitamin and iron (0.5%) and calcium propionate (0.5%). These ingredients must be measured in exact amounts to produce top quality bread. Variation from these proportions alters such things as shape, color, shelf-life (mold growth), aroma, texture, weight, size and taste.

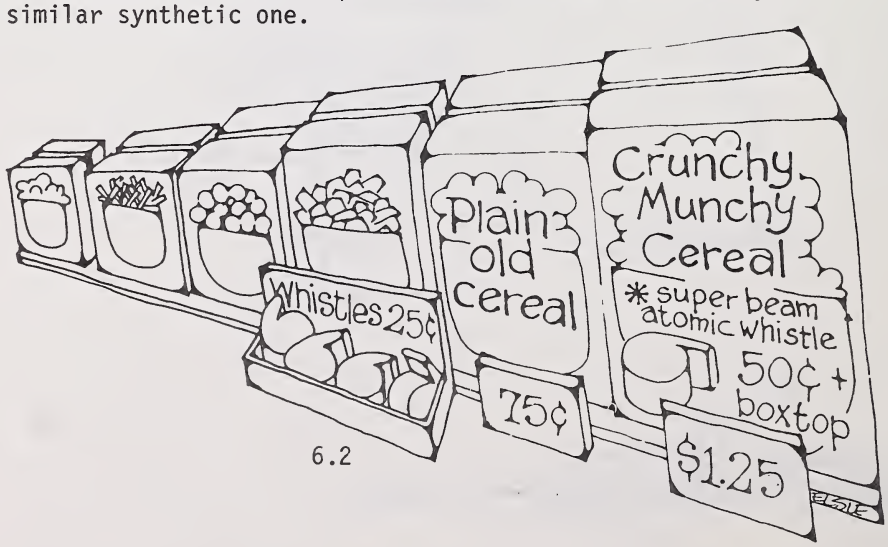
All of these characteristics are important: to the Health Protection branch of Health and Welfare Canada for food safety, to the processor for sales, and to you the consumer for appearance, taste and safety. That is why standards are set and tests performed to ensure the maintenance of those standards.

In Activity A of this lesson, students will perform quality tests on several different brands of bread. In so doing, they will gain first-hand experience with the standards a bread must meet to be sold to consumers. From the tests, students will rate the breads tested, identify those which meet the standards and those that do not, and make recommendations concerning the best kind of bread for specific situations.

Note that you must compare different brands of the same type of bread (e.g. white, brown, 60% whole wheat). If you test more than one type of bread, then each type comparison is a separate test.

Activity B is optional. It is a chemical test for the chemical mold-inhibator, calcium propionate. Calcium propionate is added to bread to enhance its keeping quality and stability so that it may be transported long distances and stored safely.

Preservatives like calcium propionate are regulated by the Health Protection Branch of Health and Welfare Canada under the Food and Drugs Act. Bread claiming to have no preservatives contains no artificial preservatives. It does, however, contain natural preservatives, like raisin juice concentrate. A natural preservative is not necessarily safer than a similar synthetic one.



PROCEDURE: Activity A

Part 1

Preparation:

1. On the first day of the activity, make a set of Quality Score Sheets for each loaf.
2. Transfer your loaves from their brand packages into clear plastic packages identified by number.
3. Record the number of each loaf on both packages so you will know which brand each loaf is.

Part 2

Introduction:

4. Explain the importance of quality control and quality testing to food safety and to consumer acceptance.
5. Describe the tests that students are to perform, and what they will learn from their results.

Part 3

The Activity:

6. Divide your class into as many groups as there are loaves.
7. Give each group a loaf without disclosing the brand-name.
8. Give each group a copy of the Bread Quality Score Sheet and allow them to perform each test on their mystery loaf.

N.B. Empasize to your students that this is not a competition - although they are working in groups, they are one team attempting to find the loaf(s) which meet(s) each standard best. Therefore, they must be as objective as possible in their evaluation.

Part 4

Conclusion:

9. On the second day, have each group describe their results, including individual test scores, and the total test score.
10. Rank the loaves, according to total test score on the blackboard.
11. Finally, reveal the brand name of each loaf for your students.

DISCUSSION QUESTIONS

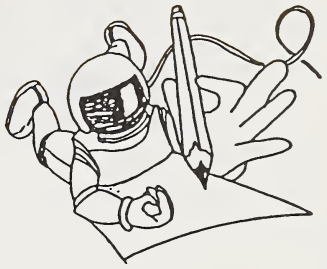
1. Which brand produced the best sample of bread? The worst?

2. What is the difference between subjective and objective evaluation? What type of evaluation was this you performed?

3. Why is it valuable to test a sample without knowing its brand name?

4. For each of the ten quality tests you performed on bread, give a reason why the characteristic is important. Are there other characteristics?

Bread moving from the oven to a slicer/wrapper.



BREAD QUALITY SCORE SHEET

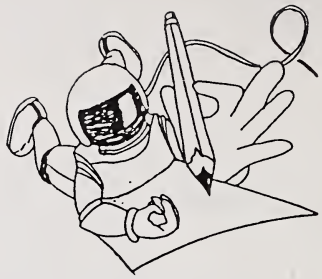
Loaf Number: _____

Test for: OUTWARD APPEARANCE

Declared Weight: _____

Specified Height: _____

	PERFECT SCORE	YOUR SCORE	STANDARD
Shape	10	_____	Take one slice from each end of the loaf (count in 5 slices on both sides). Lose 5 points if slices do not match. Lose another 5 points if loaf is caved in.
Colour	10	_____	Hold a slice up to a light source. Lose 5 points in the color is not uniform throughout the slice. Lose another 5 points if the crust is burned.
Character of Crust	10	_____	Examine crust for crushed appearance. Lose 5 points if crushed. Lost another 5 points if crust is difficult to tear.
TOTAL	30		



BREAD QUALITY SCORE SHEET

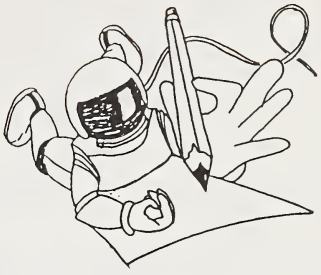
Loaf Number: _____

Test for: VOLUME

Declared Weight: _____

Specified Height: _____

	PERFECT SCORE	YOUR SCORE	STANDARD
Weight variance	10	_____	Actual weight must be within ± 7g of declared weight - lose 3 points for every 7g outside this.
Height variance	10	_____	Actual height must be within ± 1.25 cm of specified height. Lose 3 points for every 0.5 cm outside this (N.B. measure from the highest point of the loaf.)
Moisture Concent	10	_____	Actual moisture content must be within 1% of declared moisture content (37%). Lose 3 points for every 1% over 38%. Weigh the loaf to the nearest 0.1 g (A). Cut the loaf into 2-3 mm slices, spread on paper and allow to dry in a warm room overnight so that the bread is crisp and brittle. Re-weigh the loaf on the same balance to the nearest 0.1 g(b). Calculate the percent moisture as follows: $\% \text{ Moisture} = \frac{A - B}{A} \times 100$
TOTAL	30		



BREAD QUALITY SCORE SHEET

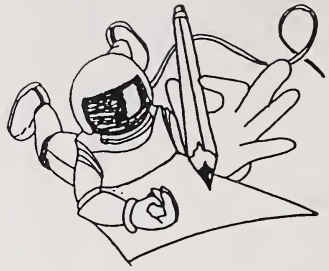
Loaf Number: _____

Test for: INTERIOR QUALITY

Declared Weight: _____

Specified Height: _____

	PERFECT SCORE	YOUR SCORE	STANDARD
Grain	10	_____	Hold a slice up to a light source. Lose 5 points if holes extend through slice (you will be able to see through the slice). Lose another 5 points if tunnels are present (very large holes).
Texture	10	_____	Hold a slice up to the tip of your nose. Move it around. Lose 5 points if it feels rough (it should feel like crushed velvet). Draw a knife across a slice as if you were spreading peanut butter (firm). Lose another 5 points if slice rips.
Aroma	5	_____	Imagine a slice as a hankerchief. Hole a slice up t your nose snugly, open your mouth and breath deeply. Score out of 5 points.
TOTAL	25		



BREAD QUALITY SCORE SHEET

Loaf Number: _____

Test for: TASTE QUALITY

Declared Weight: _____

Specified Height: _____

	PERFECT SCORE	YOUR SCORE	STANDARD
Crust	10	_____	Taste a sample of crust. Lose 5 points if crust tastes rancid or burned. Lose another 5 points if crust if very difficult to chew.
Grain	5	_____	Taste a sample of grain. Lose another 5 points if grain is flat (usually the case if the loaf has many holes/tunnels).
TOTAL	15		
GRAND TOTAL	100		

EVALUATION OF SCORE

95 - 100	Excellent
85 - 95	Very Good
70 - 85	Good
50 - 70	Fair
0 - 50	Poor

PROCEDURE:

Activity B (Optional)

Testing for presence of calcium propionate (mold inhibitor).

1. Obtain 2 slices of bread; one slice which has calcium propionate in it and the other slice which does not. Do not let your students know which is which.

2. Place each slice in a 250 ml beaker and add 100 ml or water to each. Stir the mixture with a glass rod or a spatula.

3. Drain off about 10 ml of the solution in each beaker into a test tube, holding back as much of the bread as possible with a spatula or glass rod.

4. Add 5 ml of 6M (dilute) sulfuric acid to each test tube. Watch for an immediate precipitate in one of the test tubes.

5. Add 4 ml of 95% ethanol to each test tube and heat the test tubes evenly. As the contents of the test tubes approach the boiling point, waft some of the vapors toward your nose and ask your students to come forward and do likewise. The strong odor of pineapple confirms the presence of calcium propionate.

Passing the taste test.

Random sampling of potatoes.

Activity 7

SOIL AND SEEDLINGS

Objective: Students will design a method or device to monitor seedling growth and use it to compare the effects of varying conditions on that growth.

Curriculum Fit: Grade 8: Topic 5: Growing Plants

Lesson Concepts:
Germination
Growth patterns
Soil nutrients and fertilizers

Agriculture Concepts: Importance of soil and water

Cognitive Level: Analysis

Materials Required:
Fast-growing seeds
Fertilizer
Pesticide
Soil samples
Hydroponic solutions
Salt
Water
Lamps
pH solutions
Refrigerators
Earth worms

Time Required: 4 - 8 lessons (depending on seed used)

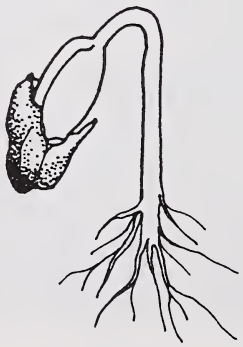
BACKGROUND

Dry seeds appear as lifeless as pebbles. They can be stored for weeks and months without showing signs of life. But as soon as one of these seeds is placed in a warm, moist place it swells, opens, and develops gradually into a fully active plant. A young plant must do more than simply grow bigger; it must grow in such a way that it can take the best advantage of the light, water, and other conditions available to it. Seedling growth is believed to be governed chiefly by hormones that are produced within the plant. The hormones are produced in response to environmental factors affecting the seedling.

In this lesson students investigate how varying environmental factors affects seeding growth. In doing this students will use scientific process skills such as observing, qualifying, communicating, inferring, predicting, hypothesising, controlling variables, interpreting data and results, formulating models, experimenting, and processing data.

The seeds chosen will have planting directions on their package. These directions should identify the ideal state of the major environmental factors affecting seedling growth. A set of seeds grown under these conditions should form the control group. Test groups can be established by varying each of the environmental factors.

You should also emphasise that ideal conditions for this particular seed are not necessarily ideal conditions for other seed species.



PROCEDURES

Part 1

Introduction:

1. With your students, make a list of some environmental factors which they think affect plant growth. Without informing the students, use the instructions on the package of the seeds you have chosen as the basis for making the list of environmental factors.

Part 2

The Activity:

2. Divide the class into groups of 2 or 3 depending on the number of factors to be tested and the class size.

3. Have each group choose an environmental factor from the list developed above and identify two different states of the factor. See attached list for examples.

4. Have each group set up an experiment in which seeds must grow under each alternative state of the chosen factors.

5. Each group must design a monitoring method or device to keep a record of results over time.

6. Students must continue the experiment, for the ideal growth period described on the package of seeds.

Part 3

Conclusion:

7. At the end of the set time period, have groups present their experiments to the rest of the class, explaining their monitoring method or device and results.

8. With your students, list the ideal state of each environmental factor and compare their results with those on the seed package.

DISCUSSION QUESTIONS

1. What is the independent variable in your experiment?
2. What variables are kept constant?
3. What are some variables that may be uncontrolled?
4. What is seed germination?
5. Could seeds germinate in outer space (where there is no air/gravity?)
6. Is digestion faster in seedlings or in ungerminated seeds?
7. How can you prove this? (Grind seed/seedlings and do nutrient tests.)
8. What causes stems to bend (is it purposeful or automatic responses?)

RELATED ACTIVITIES

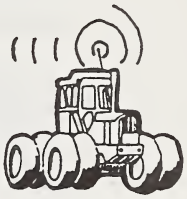
After ideal growth conditions have been determined for this particular seed, try using a variety of seed species under these conditions, showing the student that different plants have different needs.

LIST OF SELECTED ENVIRONMENTAL FACTORS THAT AFFECT PLANT GROWTH

FACTOR	STATE 1	STATE 2	STATE 3	STATE 4
Soil	course sand	fine clay	none (hydroponic solution)	(control)
Light	window sill	cabinet drawer	florescent	
Water	add 100 ml daily	none added	add 500 ml daily	
Temperature	room temperature	refrigerator	heater	
Air	inside	outside	electric fan	
Salinity	twice the tolerance level	no salt added	small amount added	
pH	very acidic (2)	neutral	very alkaline (10)	
Organic Matter Living Organisms	earthworms, soil peatmoss	soil, peatmoss	sterilised soil alone	
Colour of Surroundings	red	green	white	
Effect of Gravity (on seedling)	Pin seedling to a cork in a pan of water and cover with a metal can			
*Fertilizer	twice recommended amount	none added	half recommended amount	recommended amount

* Caution: handle with care - read and follow directions on package

Activity 8



LET IT GROW

Objective: The students will grow new plants from cuttings of non-reproductive tissues from old plants.

Curriculum Fit: Grade 8, Topic 5 - Growing Plants

Lesson Concept: Plant propagation by vegetative reproduction
Growing plants from cuttings

Agricultural Concepts: Diversity

Cognitive Level: Comprehension, Applications

Materials Required:
planting mixture
plant pots or growing trays
plants and plant cuttings
- geranium
- potato tuber
- top 1/2 inch of carrot roots
- pineapple tops
- willow or dogwood branches

water
- spider plant
- rooting hormone

Time Required: 20 - 40 minutes to take cuttings and plant them, 1 minute per day to water and record changes, one period to discuss results.

BACKGROUND

Cloning is the developing of new individuals from the non-reproductive cells of an existing individual. In animals this procedure is very difficult as it requires that scientists decipher the process of call specialization and determine ways to reverse it. These questions are unresolved to date.

Plant cells do not seem to present the same degree of irreversible specializtion found in animals. As a result, cloning has been possible on a horticultural level for many years. The common methods of getting many copies of a single plant are called vegetative propagation. Root cuttings, stem cuttings, leaf cuttings, and layering are common procedures.

In this lesson, your students will grow a variety of new plants from old ones. In each variation, the process involves having cells of one type respecialize to develop organs (roots or stems or leaves) that were removed in taking the cutting.

PROCEDURE

Part 1

Introduction:

1. Explain to students the relationship between vegetative reproduction and cloning.
2. Inform them that in this activity they will be developing clones of some sample plants by cutting off particular pieces and growing them.

Part 2

The Activity:

3. Divide the class into groups of two or three.
4. Give each group a plant or source of cuttings, and the matching propagation instructions.
5. Each group is to make cuttings following their instruction sheet and plant the cuttings in a pot or tray of growing mix.

   NOTE: Results will occur sooner if students dip the cut end in rooting hormone.

6. Students will need to water their parts regularly, and should record changes daily.

Part 3:

Conclusion:

7. Have students report on how long their cuttings took to establish roots and how much they grew during the experiment.

8. Ask students to speculate on reasons why a farmer might prefer to establish a group of plants vegetatively instead of by seed.

DISCUSSION QUESTIONS

1. What are some common examples of plants that are grown vegetatively rather than from seed?

2. What are some advantages to a grower of having all plants identical?

RELATED ACTIVITIES

1. Develop a bulletin board display that illustrates various methods of propagating plants using vegetative methods.

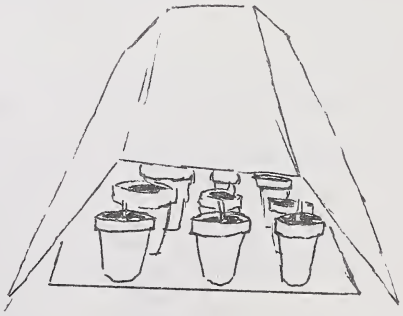
2. Invite a horticulturalist, African violet grower, potato grower, or other expert to demonstrate plant division and propagation to your class.

DATA SHEET 1 - PROPAGATION BASICS

Some plants will root in water. For example, ivy, impatiens, willow (sometimes) and many of the soft stemmed house plants.

Most plants will root more strongly in a moistened mix of ½ peat moss and ½ coarse sand, vermiculite or perlite.

All plants but cacti will root most easily if they are regularly sprayed with water and protected from evaporation by a plastic sheet.



Dipping the lower end of a cutting in rooting hormone will speed up rooting.

DATA SHEET 2 - PROPAGATION WITH TUBERS

Tubers are fleshy underground roots or stems that some plants develop to survive harsh conditions. Potatoes are the food crop most commonly grown this way.

Cut a potato into several pieces, making certain that each piece includes 2 or 3 eyes.

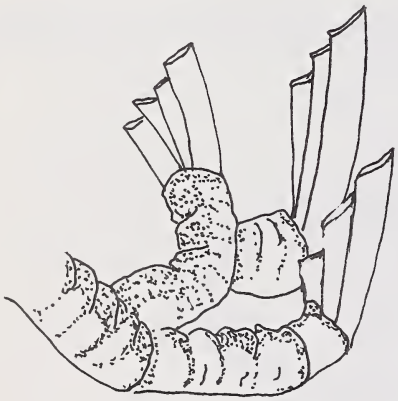
WHAT TO DO

1. Push each piece into the rooting mixture and cover lightly.
2. Press down while still dry.
3. Water regularly until leaves appear above the soil.

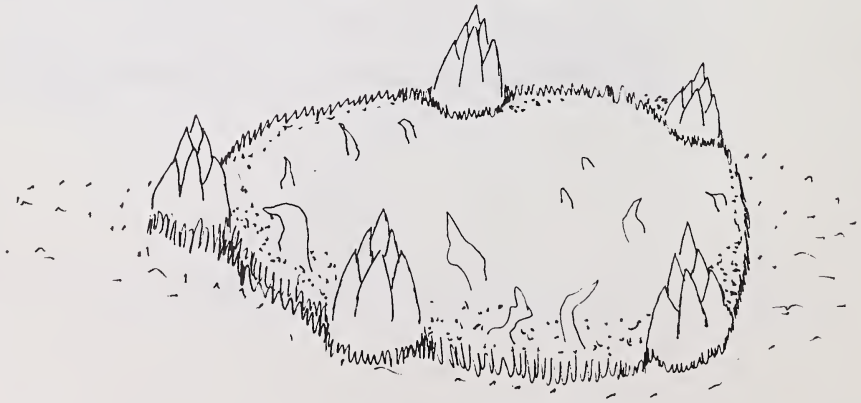
DATA SHEET 3 - DIVISIONS

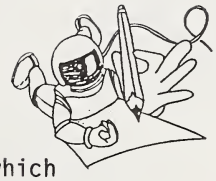
Besides tubers, plants produce other base or underground structures that can be divided so that a new plant will grow from each one.

RHIZOMES - underground stems with growth nodes that will produce new plants. Examples: iris, Lily of the Valley, and quackgrass.



CROWNS: small plants, buds or shoots that grow around the base of parent plant. Examples: rhubarb, ferns.



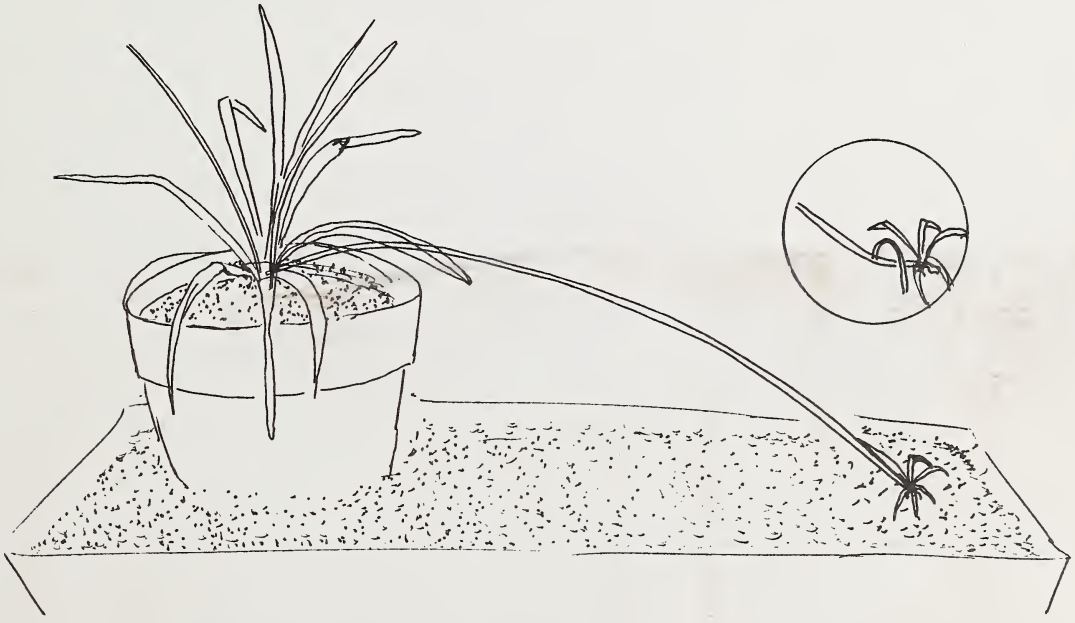


DATA SHEET 4 - RUNNERS AND OFFSETS

Many plants produce a long leafless stem called a runner which grows a complete new plant called an offset at its end.

Strawberries are the best known food plant. A strawberry grower, besides gathering berries, must choose some offsets to root every year to replace old plants.

The spider plant is used here because it is easier to work with.



WHAT TO DO

1. Place a potted spider plant in the center of a tray of rooting mixture.

2. Use an opened paper clip to pin offsets into the mix.

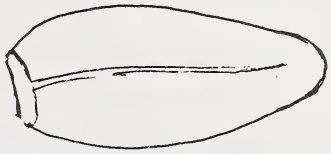
3. When your offsets are clearly rooted (expect about two weeks) cut them away from the large plant and establish them in their own pots.

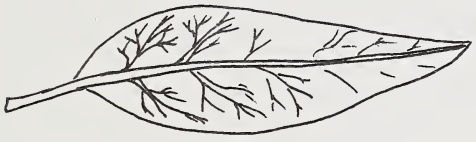
DATA SHEET 6 - LEAF CUTTINGS

Many soft-stemmed plants can be reproduced from single leaves or a leaf and its stalk.

This technique is commonly used for houseplants.

Leaf Blade cuttings - used especially for cacti and succulents. Let the cut end of the leaf dry before planting. Water sparingly.





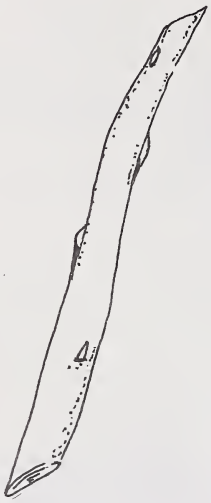
Leaf-Petrole cuttings - used for geraniums, African violets and other potted plants. Remove the leaf plus about 3 cm of its stalk and place in water or rooting mixture.

Leaf-Bud cuttings - used for rubber trees, hibiscus and most other woody plants. Cut the leaf, its stalk, and a bit of stem including the bud where the petiolte meets the stem (axial bud).

DATA SHEET 7 - STEM CUTTINGS

Woody, perennial plants are usually propagated by cutting pieces of stem with the leaves attached. These are dipped in rooting hormone and stick into a coarse planting mixture. There are two major types:

Hardwood Cuttings



- Taken during the dormant season
- Stored through winter for planting in spring
- Should be 6 - 12 mm in diameter, long enough to have 3 or more buds
- Poplar, Willow Alder, Dogwood

Softwood Cuttings

- Taken in late spring or early summer
- Should be gathered in early morning or on a rain day.
- Take about 10 cm at the growing tip of the branch.
- Remove lower leaves.
- Clematis, apple, rose, dogwood, willow

Activity 9

SASKATOON PIE

Objective: Students will develop a strategy for domesticating a wild plant that produces edible fruit.

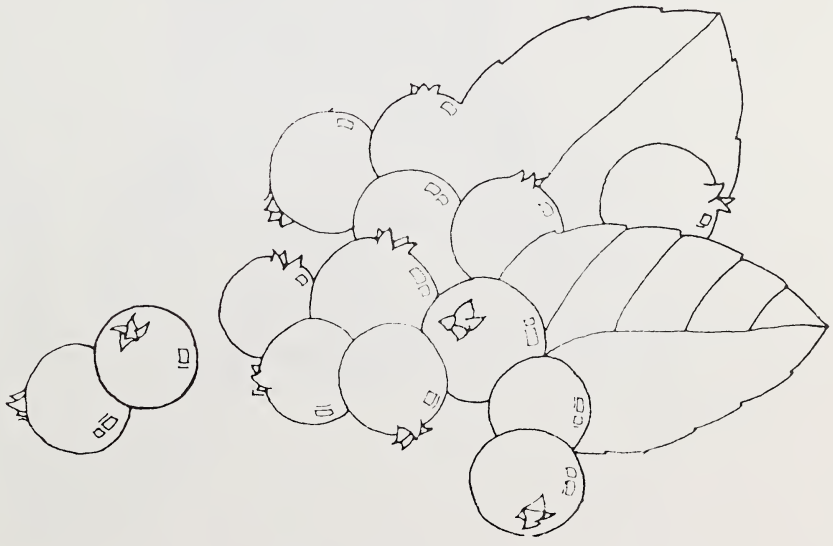
Curriculum Fit: Grade 8, Topic 5 - Growing Plants

Lesson Concepts:
Plant propagation by vegetative reproduction
Flowering and seeds
Specialized varieties, plant breeding
Awareness that agricultural plant varieties are usually the product of intensive breeding

Agricultural Concepts:
Diversity
Capital and Technology Intensive

Materials Required: Information about saskatoons (included)

Time Required: One 40 minute period



BACKGROUND - For the Teacher

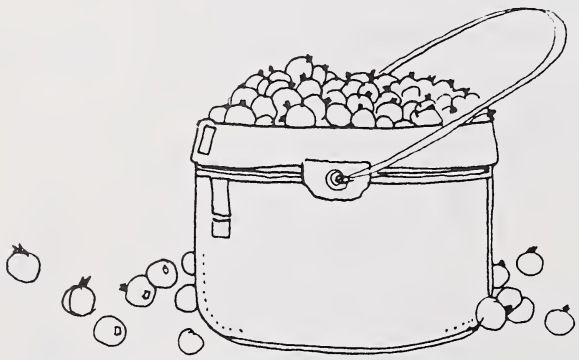
Agricultural research covers a variety of topics, most of which aim at improving an existing crop, developing new uses for a crop or finding better ways to process a crop. Another important type of research is the search for completely new crops.

The saskatoon (Amelanchier alnifolia Nutt.) or serviceberry is a common wild plant throughout Alberta. Because its fruit is widely popular, it has become the subject of research aimed at developing it into a bush fruit orchard crop.

Early research focused on selective breeding from wild stock to develop domestic varieties with particular characteristics. Several varieties are now available.

A new stage of research, still in progress, is to use cloning and propagation techniques to develop bushes that are so similar genetically that an entire orchard could be expected to ripen at once. This short harvest season is essential to an economically sensible orchard.

In this lesson, your students are asked to design a scientific program to domesticate the saskatoon. Using selective breeding and crossing techniques, or propagation techniques, they will recommend a strategy for attacking this problem.



PROCEDURE

Part 1

Introduction:

1. Explain to the class how selective breeding can exaggerate certain characteristics.

2. Review the propagation techniques covered in Activity 8.

Part 2

The Activity:

3. Divide the class into working groups of four or five.

4. Tell the groups that you have a wild fruit plant, the saskatoon, which you want to domesticate so that farmers can grow it in orchards.

5. Ask each group to list the steps they would take to:

   a) produce dependable bushes from wild plants, and
   b) develop cloned bushes for regular cropping.

Part 3

Conclusion:

6. Each group is to present their research program to the rest of the class.

DISCUSSION QUESTIONS

1. Based on the information on the Saskatoon Facts Sheet, how many years will your program take to complete?
2. Are there any ways we can speed up this process?
3. What are some ways to use saskatoons?
4. What are some other wild, Alberta plants that could be domesticated to give new crops.

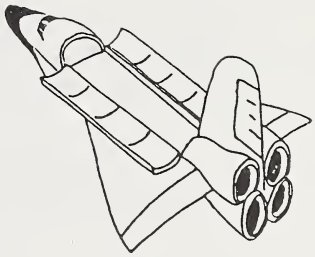
RELATED ACTIVITIES

1. Invite a speaker to describe modern plant breeding techniques.
2. Bring in wild plant products that could be used for new crops.

Saskatoons - your product of the future.

DATA SHEET 1

Saskatoon Facts



A native shrub, 4-5 m tall.

Most successfully grown from seed. Seeds must be separated from the fruit, scratched with sandpaper and stored in damp peatmoss at 2 - 7°C for 90 days to ensure germination.

Vegetative propagation has shown limited success by means of suckers, root cuttings, and soft wood cuttings. These are all more difficult than growing from seed.

The shrub has a long juvenile phase: it takes 6 years to produce any fruit and 8 years to reach full production.

Orchard plants must be irrigated in case of drought and have well draining soil during wet years.

Activity 10

DIRTY BUSINESS

Objective: Student will learn how soil texture effects plant growth by performing settling tests, porosity tests, and seed growth tests.

Curriculum Fit: Grade 8, Topic 5: Growing Plants
Topic 6: Interactions and Environments

Lesson Concepts: Germination
Soil nutrients and fertilizers

Agriculture Concepts: Importance of soil and water

Cognitive Level: Application

Materials Required:

- soil samples taken from different land areas
- 100 ml graduated cylinders
- water
- large waste basket (water proof)
- paper towels
- transparent, plastic, cling wrap
- soil samples collected from different locations
- 4 plastic 1 litre bottles
- cloth 1 sq. m.
- 8 - 500 ml beakers
- fast growing seeds
- 4 3-inch plant pots

Time Required: 2 - 3 lessons

BACKGROUND

Dirt (or soil) consists of two parts: solid part and pore space. Mineral particles and organic matter make up the solid part of the soil, while air and water occupy the pore space. Soils vary in their proportions of these components, and the proportions affect the quality of the soil for agricultural use.

For ideal plant growth, an agricultural soil needs to provide

- at least 15 cm of topsoil,
- 45% mineral matter, 5% organic matter and 50% pore space,
- a loamy texture and aggregated structure,
- living microbes and invertebrates,
- a balanced supply of nutrients, and
- correct acidity (pH).

In such a soil, with adequate rainfall and good management, crops should flourish.

Water and air are essential for plant growth and the activity of soil micro-organisms. The pore space allows for the exchange of gases between the soil and the atmosphere above the soil. The pore spaces also hold water under varying amounts of tension. This lesson depends on the amount of water and the size of the pore spaces.

Mineral particles are grouped by size into three categories - sand, silt, and clay. the proportion of these particles determines the soil texture. Texture has an important influence on many soil properties including size of pore space, water holding capacity, structure and tilth (the physical state of a soil with respect to plant growth), consistency (the feel of a soil at varying moisture contents) and bulk density (dry mass per unit volume).

In this lesson, students will test soil samples with different textures in order to see how texture affects the properties mentioned above. One test will determine percent composition of the mineral component of several soils; another will demonstrate the ability of different soils to absorb and hold moisture; and a third will demonstrate the ability of different soils to absorb and hold moisture.

NOTE: Test 1 has two parts which must be separated by a 30 minute settling time. Test 2 can be run and test 3 can be set up during this time. Test 3 must be monitored for one or two minutes a day for a week.

PROCEDURE

Part 1

Preparation:

1. Gather soil samples from several different locations. If some of your students are from farms they may be able to bring samples. You can test any soil types that are available so long as you have several different ones. If forced by circumstances, you can make soils of different types by mixing potting soil, sand or perlite, and peat in different combinations.

2. Set up the testing apparatus for your students.

Part 2

Introduction:

3. Explain that soils differ in their constituents and that these differences change a soil's value to plants.

4. Show your students the sample soils and divide them into as many groups as there are samples.

5. Give each group a soil sample and two 100 ml graduated cylinders.

Part 3

The Soil Test:

6. To determine the mineral composition of the soil, your students should:

Test 1, Part A

a) crush their soil and clear it of sticks, litter, and large lumps.
b) fill one cylinder to the 15 ml mark with loose soil.
c) add enough water to fill the cylinder to the 45 ml mark.
d) cover the cylinder opening with plastic wrap and shake it vigorously for at least three minutes. They must ensure that nothing spills and that large soil particles break up.
e) set the cylinder down and let the contents settle for <u>exactly 30 seconds</u>.
f) pour the water and suspended particles into the second cylinder to stand for 30 minutes.
g) record the volume of settled solid in the first cylinder.
h) pour out the settled material.

Soil ready to do its work.

Preparing the soil for planting.

i) rub it between their fingers and record the consistency.

gritty - sand
slippery - silt
sticky - clay

Test 2

7. To test their sample for water holding capacity, your students should

a) cut the top and bottom off of a plastic bottle, keeping the cylindrical centre portion.
b) fasten a filter cloth over one end.
c) add 500 ml of their crushed and screened soil sample to the filter cylinder.
d) mount the cylinder on a funnel above a graduated cylinder.
e) quickly pour 200 ml of water into the top of the cylinder, marking the start of the pour as time 0.
f) record - 1. how long it takes for water to begin to drip through the filter.
2. the total volume of water that drains out.

Test 3

8. To see how well the soil supports plant growth, each group should

a) fill a small plant pot with their soil.
b) plant a few seeds in the pot, following package directions.

NOTE: all groups should use the same kinds of seed. To test various plants they must establish a pot of soil for each type.

c) put their test pot in a well lit place.
d) add 25 ml of water daily
e) record the time until the seeds sprout, the daily increase in height for one week after sprouting and any other apparent changes in the plants as they grow.

Test 1, Part B

9. Once graduated cylinder 2 has settled for 30 minutes students should

a) record the amount of settled material in the bottom of cylinder 2.
b) pour off the water and suspended particles, without disturbing the settled layer.
c) test the settled layer between their fingers and categorize it as previously done (step 3).

Above - Strip farming to conserve soil.

Across - A student project on soil conservation.

H.T. Coutts School 1987 Agricultural Fair. Claresholm, Alberta.

Part 4

Conclusion: 10. Ask students to briefly state how the mineral particle composition of soil affects its water holding capacity and its usefulness to plants.

DISCUSSION QUESTIONS

1. Why did the sand settle first?
2. Why do you not wait for the clay to settle?
3. The best soils, called loams, are even-textured. How does your soil compare?
4. Which soil type held water the best? Why?
5. What is the relationship between size/number of pores and adhesion/cohesion forces?
6. What is humus and what role does it play in plant growth?
7. Which soil type yielded the fastest sprouting seeds?
8. Which soil type yielded the fastest growing sprouts? Why?

RELATED ACTIVITIES

1. Take your students on a field trip to various locations comparing soil horizons (topsoil,subsoil, parent material) by obtaining soil profiles with a shovel.
2. Conduct chemical soil tests.

OUTSIDE RESOURCES

A Matter of Soil (Alberta Agriculture film)

Activity 11

THE INCREDIBLE NATION-WIDE BALANCING ACT

Objective;	Through applying several classroom activities to agricultural case studies, students will be able to define optimum and maximum as these concepts apply in agriculture.
Curriculum Fit:	Grade 8, Topic 6: Interactions and Environments
Lesson Concepts:	Awareness of the complex interrelationships among living things and their environments Awareness of the nature and extent of impacts on environments caused by human actions
Agricultural Concepts:	Economic importance
Cognitive Level:	Comprehension, Application, Evaluation
Materials Required:	cups or glasses water 6 buckets measuring container mop and pail
Time Required:	1 - 2 lessons

BACKGROUND

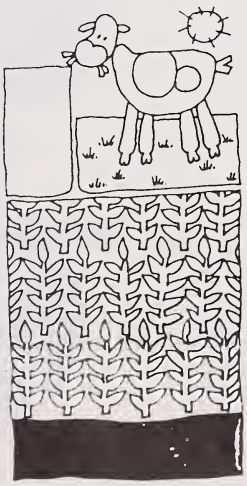
Human systems are frequently designed to produce the maximum amount of some intended result. This concentration on producing as much of one commodity or activity as possible leads to problems with by-products, waste products and other unexpected interactions with the larger world.

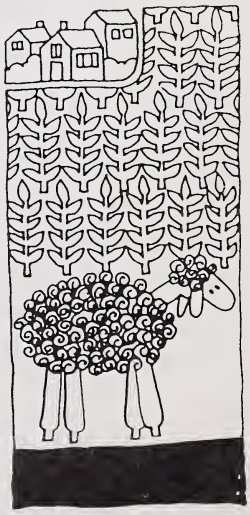
The understanding that the world goes beyond direct cause-effect and stimulus-response has led to the design of more sensitive systems which seek an optimum rather than a maximum output. In order to achieve optimum production, a balance must be reached among multiple goals that are at least partly conflicting.

For example, farms that are too small are not economically viable because they cannot produce enough to cover production and machinery costs and still leave the farmer with enough profits to live on. Such farms, if they do manage to continue in operation, are labour intensive since they cannot support much mechanization. On the other hand, farms which are too large cannot be operated efficiently enough to make the best use of land and human resources. The shortness of the growing season and difficulties in procuring experienced farm labour often doom excessively large operations. The optimum scale then, lies between these two extremes where a farmer has enough land and livestock to support the use of large, efficient machinery, yet not so much as to require unavailable extra manpower to complete the work.

In this activity your students will learn that maximum production is not necessarily optimum production. Just as farmers must control their production to reach optimum levels, so students must control their production, in both the mock quiz and the bucket brigade race, to achieve optimum results.

Treat the mock quiz like any other quiz you give the students - they must take it seriously for the concept to work. In the bucket brigade race, you must act as a judge making sure all spilt cups are eliminated from the race.





PROCEDURE

Part 1

Preparation:

1. Make copies of the Quick Quiz pages.
2. Arrange materials for the relay race demonstration.

Introduction:

3. Tell your students that you have a surprize quiz for them and that they may have 1 minute to answer the questions.
4. After 1 minute, ask how many read the instructions. Then ask how many did not have time to answer the last question, which counted for 55% of the exam?
5. Ask your students what they hoped to accomplish in writing the quiz and how they went about the task.
6. Explain that many activities in life have multiple goals; some of which may conflict; and all of which must be considered in order to obtain optimum results.
7. Go over the quiz with your students just to emphasize the importance of the agricultural industry in Alberta.

Part 3

The Activity:

Bucket Brigade Race (Part I)

8. Divide students into 3 teams; team A fills their cups brimful; team B fills their cups to a level which ensures fast delivery with no spillage; team C fills their cups one quarter full.
9. The object of the game is to get the most water in a bucket in 3 minutes by relaying as many cups of water down a brigade as possible.
10. A penalty is placed on any team spilling their cup (must be eliminated before reaching the bucket).
11. A team can start passing another cup as soon as they pour a cup into the bucket.

12. Compare water levels in the 3 buckets after 3 minutes are up.

13. Have each team clean-up their spilt water.

Bucket Brigade Race (Part 2):

14. Re-run the race as before except this time the team must stop for 30 seconds after pouring 20 cups into the bucket.

15. Compare water level in the 3 buckets after 3 minutes are up.

16. Use discussion questions after the game.

17. Again have each team clean-up their spilt water.

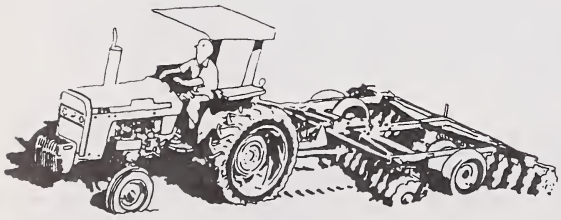
Part 4

Conclusion:

18. Explain that just as there were restrictions placed on the amount of water you could carry, farmers also have restrictions placed on the amount of crop and livestock they produce.

19. Hand out the case study to each student and then answer the questions.

20. Have students come up with a suitable definition for optimum and maximum from what they have learned in the lesson.



DISCUSSION QUESTIONS

1. How did you feel about the restriction in the Bucket Brigade Race?

2. What would happen if there were no restrictions?

   e.g. - no clean-up after the game
   - no penalty for water loss
   - no quota on amount of water that can be delivered

3. Is maximum always/ever optimum?

RELATED ACTIVITIES

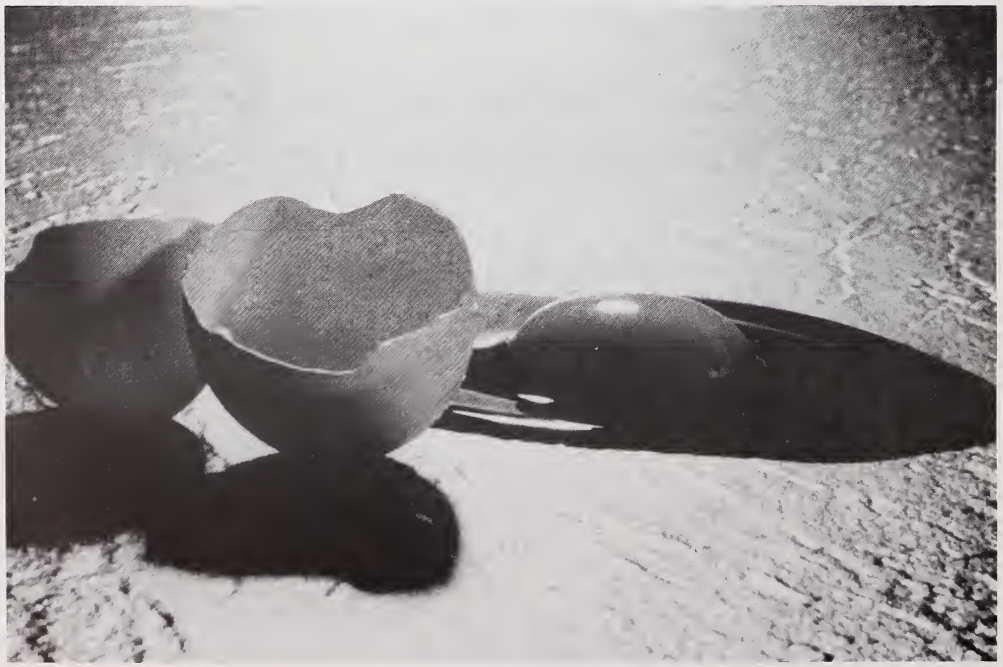
1. Look for other case studies of optimization in farming:

   e.g. Fertilizer Use: Making sure added returns are greater than added costs. See Fertilizer Economics, Alberta Agriculture, July, 1985, Agdex 822-11.

KEY

1. c
2. c (large tractors = $50,000.00; car = $6,250.00)
3. b (acre = 43,000 square feet; football field = 48,000 square feet)
4. a
5. c (one tree = 5 to 10 bushels, 60 lbs. per bushel; one pie = 2 pounds of apples)
6. d
7. a
8. c
9. b
10. d

Not too many, not too few. Produce just enough.



CASE STUDY OF OPTIMIZATION IN FARMING

The Alberta Egg and Fowl Marketing Board established in 1968, offered egg producers a supply management system. Prior to that time, the egg industry was very chaotic, with dramatic fluctuations in egg prices. If prices were favourable, farmers over-produced, which caused a drop in prices. Producers then cut back on their production, which led to shortages and high prices. Often there were a great many more eggs being produced than could be used. In establishing a marketing plan, producers accepted production limits in return for more stable incomes.

Now, the Board determines the number of eggs which consumers will need and sets production levels to meet that need. Each producer has a quota of the dozens of eggs which he may produce and market. He sells his eggs to a grading station, which sorts them according to size and grade. The eggs are then sold to retail stores, which sell them to you, the consumer. The price paid to producers for their eggs is determined using the "cost of production" formula which takes into account all the costs that go into producing eggs, including feed costs, the cost of laying hens, upkeep of buildings and equipment, labor, and a return on investment.

The figures that go into the pricing formula are based on the average costs of efficient producers. this means that no farmer is guaranteed a good income; if a producer is ineffieient, his income won't cover his expenditure. Pricing eggs in this way means there are no drastic price swings, (as there were before stabilizing pricing was introduced) and insures a steady supply of eggs to you, the consumer. Quotas were originally set up be numbers of eggs, but it soon became evident that all eggs did not move off the farm to graders or processors. Since many producers grade their own eggs and sell them directly to the consumer, monitoring this kind of system proved impractical. As a result, quotas were converted to an equivalent number of hens permitted each producer. The quota then became all the eggs a producer is able to produce from a given number of hens. Under this system, the incentive to produce more eggs from the same number of hens is always present. Increased efficiency can result from better hens, improved management, equipment, feed formula, or handling practices. As the rate of lay improves, the production cost is reduced. This, in turn lowers the price of eggs to the consumer. Through this system the interests of consumers as well as producers are protected.

QUESTIONS FOR ANALYSING THE CASE STUDY

1. What benefits results from a quota system?
   a) to the egg farmer?
   b) to you, the consumer?

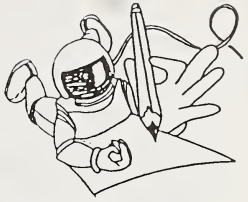
2. How do you think the egg farmer would treat his chickens under this system?

3. If there are surplus eggs, why not just lower the price to get rid of them?

4. Do you consider this to be a fair system to all egg farmers; rich or poor?

5. How might you change this system?

The optimizing bird.



QUICK QUIZ

How much do you know about farming? Here's your chance to find out.

Circle what you think is the best answer for each question below. Don't be afraid to guess. Many adults don't know the answers to the questions.

Instructions: You have 1 minute to complete this quiz. The first nine questions count one mark each. The last question counts eleven marks. The total marks possible is 20.

1. One Alberta farmers grows enough food each year to feed and clothe how many people?

    a) one
    b) 22
    c) 77
    d) 250

2. A large tractor used by an Alberta farmer may cost as much as how many new small cars?

    a) two
    b) five
    c) eight
    d) four cars and a dirt bike

3. One acre of land is about the same size as a

    a) large swimming pool
    b) football field
    c) giant pizza
    d) tennis court

4. How long does it take a newborn calf to become full grown?

    a) 18 months
    b) 5 years
    c) 2 years
    d) 18 years

5. An average fully grown apple tree will produce apples for about how many pies every year?

    a) 25
    b) 2250
    c) 225
    d) I'm too busy eating pie to care

6. A single chicken lays how many eggs per year?

    a) 365½
    b) 100
    c) 420
    d) 240

7. Which crop in Alberta takes up more land than any other?

    a) wheat
    b) corn
    c) spaghetti
    d) cotton

8. One dairy cow produces how many glasses of milk daily?

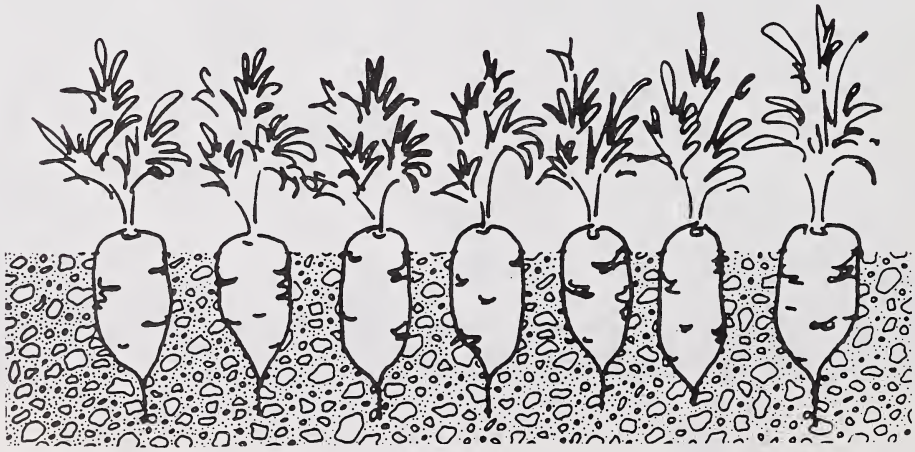
    a) 150
    b) 1
    c) 72
    d) 12

9. To reach a market weight of 220 pounds, a pig must eat how many pounds of feed?

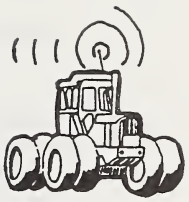
    a) 220
    b) 680
    c) 1000
    d) 100

10. How many carrots are there in the picture below?

    a) seven million
    b) one seventh
    c) none - those are watermelons
    d) seven



Activity 12



DON'T BUG ME

Objective: Students will identify an insect, relate structure to function in terms of insect feeding habits, and propose efficient pest control methods.

Curriculum Fit: Grade 8, Topic 6: Interactions and Environment

Grade 9, Topic 1: Diversity of Living Things

Lesson Concepts:
Food chains and food webs
Dependencies between living things
Adaptation in structure and behaviour
Systems of classification - dichotomous grouping

Agriculture Concepts:
Economic importance of agriculture
Production, processing and distribution system

Cognitive Level: Comprehension, Evaluation

Materials Required:
Real or illustrated insect specimens
Box
Key of insect structure (attached)
Key to food sources (attached)
Farm layout (attached)
Insect information sheets (attached)

Time Required: 2 - 3 class periods

BACKGROUND

The remarkable ability of insects to invade and colonize various changing habitats around the world is better understood if one considers some of the attributes which have allowed insects to achieve their dominant position in the animal kingdom. Since recorded time, man and insects have coexisted either because of over-lapping habitats or because human activity creating suitable insect habitat. Insects continue to plague man in his attempt to improve and protect his food supply, health, and belongings, while at the same time minimizing disruptions of the environment.

In this lesson, students will identify 14 common agricultural pests of Alberta and their food source. By looking at the type of damage they cause on agricultural products, student should infer a connection between structure and function. Students also consider pest control methods both economically and in terms of effectiveness.

Knowledge of insect life cycles and the relationship among pest, host plant, and natural enemies, help the pest manager to identify a suitable control method. Students will interpret given information about insect pests in order to come up with the best possible control method. An integrated system of pest management, one involving some or all of the proposed methods, is often best and students may discover this.

NOTE: The two identification keys will give your students experience in identifying unknown things by a process of dividing classes into progressively finer subclasses. This process is important in biology. However, in several instances, we have compromised the basic taxonomic rule that you must always use permanent structural characteristics as the basis of identification. Most of these compromises occur in the key of food products and involve grouping by use rather than structure.

PROCEDURE

Part 1

Preparation:

1. Photocopy the illustrated insect specimens, cut the cards apart and put them in a box.

2. Make one copy of each Insect Information Sheet and one copy per group of the Insect Structure Key and Food Source Key.

3. Make one large class copy of the Insect Structure Key, Food Source Key, and the Farm layout (attached).

Part 2

Introduction:

4. Show your students the farm layout and the box with the insect specimens inside it.

5. Tell them that you have some insect pests in the box and you are going to turn them loose on this Farm. Ask students what they mean by "pest" and how an insect gets to be one.

6. Inform them that their job is to first identify the insect, then identify its food source, and finally figure out a suitable control method for the pest.

7. Divide your class up into groups of 2 or 3 and hand out copies of the Farm layout, the Insect Structure Key and the Food Source Key to each group.

Part 3

Identifying Insects:

8. Have each group of students

   a. draw one insect out of the box.
   b. find the Insect Information Sheet for their insect.
   c. identify their insect by using the Insect Structure Key, the Food Source Key and the Insect Information Sheet.
   d. find their insect's food source from the Insect Information Sheet.

e. Draw straight lines on the Insect Structure Key from their insect to its food source. (There may be more than one line.)
f. draw a small picture of their insect and place it on the large copy of the Insect Structure and Food Source Key.
g. place copies of their drawing on the large farm layout in the area assigned to its main food sources.

Part 4

Choosing Pest Control Methods:

9. Now divide your classroom into three sections - designate one section for the Cultural Control of Insects, one section for the Biological Control of Insects and one section to the Chemical Control of Insects.

10. Have each group go to the section of the classroom that best represents the control method described on their Insect Information Sheet. Groups may discover that a combination of the three control methods is best.

11. Have the groups discuss ways of determining whether a pest control method is economically worthwhile and alternate control methods which might be possible.

FOR DISCUSSION

1. Do the mouthparts of mosquitoes and grasshoppers illustrate a connection between structure and function? Give examples.

2. How do farmers determine whether a pest control method is economically worthwhile?

3. To what degree is damaged food still suitable for human consumption?

4. What seems to be the best approach to pest control?

5. Does it help to know more about an insect pest when determining which control methods to use? Why?

RELATED ACTIVITIES

1. Investigate some of the more advanced and interesting pest control methods used on Alberta farms.

2. Find out the cost of various methods for controlling insects in dollars per acre.

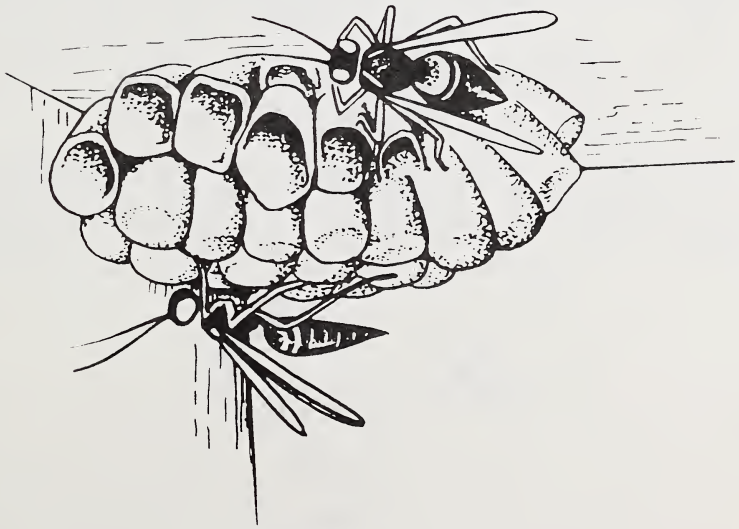
3. Identify sources, ordering procedures, import restrictions and other information for biological control agents.

4. Develop a poster advocating one form of insect control.

5. Make a list of all of the pets the class can think of and ask each student to develop a dichotomous key that would allow an extra-terrestrial to separate them.

6. The two keys on Data Sheets 6 and 7 both break fundamental rules of key construction for life science. Find out what the rules are and evaluate these keys.

7. Have students establish an insect collection of insects that significantly effect agriculture.



DATA SHEET 1

WHAT IS A PEST?

A pest is any organism that adversely influences the welfare of humans by affecting their health, food, lodging, or fibre production. This can include anything from the tent caterpillar that consumes ornamental trees and strips the poplar of its leaves to the mosquito that carries equine encephalitis (sleeping sickness) to horses and humans, the warble fly grub that feeds off livestock, the bacterial ring rot that destroys potatoes in storage, or the wild oat plant that reduces the yield of wheat.

HELPFUL INSECTS

Scientists think about one-tenth of all insects may be directly helpful to man's economy. Assistance from this small group of beneficial insects could be essential to our survival. Furthermore many insects benefit us indirectly.

At least fifty of our important food crops depend on pollinating insects, such as bees, for setting of fruit and resultant seed. Insect pests could soon ruin crops and vegetation but for predatory insects that capture and feed on other insects, and parasitic species that help check insect pests.

The scavengers receive our thanks for helping keep the earth clean and sanitary. Some insects help to aerate, fertilise, and condition the soil. There are insects that make shellac, others dyes; the silkworm produces silk, and only bees make honey and beeswax. Other benefits from insects are; providing food for fish and animals, aiding scientific research, and producing certain medicinal substances.

Knowing man's friends in the insect world can be important in controlling his enemies. Entomologists study the life cycles of the beneficial insects, learning how to utilise them to our fullest advantage.

DATA SHEET 2

INSECT MANAGEMENT STRATEGIES

Certain weeds, insects and microorganisms exploit the agricultural environment, using a significant portion of our yearly harvest if they are not controlled. Farmers use many methods to control this.

CHEMICAL METHODS OF PEST CONTROL

Chemical methods mainly include the use of pesticides such as herbicides, insecticides and fungicides. The occurrence of resistance to pesticides and examples of harmful side effects have made it necessary to use different methods of controlling pests. The alternatives include cultural and biological control and integrated pest management.

CULTURAL METHODS OF PEST CONTROL

Cultural methods of pest control include using physical or mechanical means to prevent pests from getting established. Foremost among there are tillage, crop rotation, summerfallow, and the use of weed-free seed.

BIOLOGICAL CONTROL

Biological control of pests depends on the use of living organisms to keep pests from multiplying out of control. These control organisms may act on the pest through predation, parasitism or infection.

INTEGRATED PEST MANAGEMENT

If all the available methods of controlling pests are used in combination, rather than individually, more effective pest control can be achieved. Cultural, biological and chemical methods can be integrated into a total package of pest control called integrated pest management. This strategy depends on a detailed knowledge of the life cycle and natural history of each pest species.

DATA SHEET 3: INSECT LIFE CYCLES

METAMORPHOSIS

Newly hatched insects often do not resemble the adult form. These immature insects must undergo changes in form. All young insects undergo metamorphosis whether this be simply increasing in size or acquiring new adult structure. The two common types of metamorphosis are incomplete (simple) and complete.

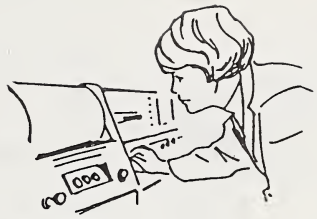
INCOMPLETE (SIMPLE) METAMORPHOSIS

This form of metamorphosis includes three developmental stages: egg, nymph and adult. The nymph closely resembles the adult except in size, colour, shape and/or presence of wings and sex organs. As the young (nymphs) mature, they gradually become more similar to the adult. As the nymphs grow, they must undergo a series of molts at which time they shed their rigid exo-skeleton or "skin". With few exceptions, both adults and nymphs display similar habits, and live and feed on the same host. Some insects showing this lifecycle are the grasshopper, bugs, aphid, thrips, and lice.

COMPLETE METAMORPHOSIS

This life cycle includes a metamorphosis through four developmental stages: egg, larva, pupa, adult. In this type of development, the young or larvae (ex. maggots, caterpillar, grubs) do not resemble the adult, larvae, like nymphs, require periodic shedding of the "skin" in order to grow before transforming into inactive pupae. Pupae are usually covered by a cocoon or some other protective coating. During this stage of development, extensive tissue reorganisation occurs in which adult structures replace larval structures. Insects with this life cycle patterns include flies, beetles, moths, and keds.

DATA SHEET 4

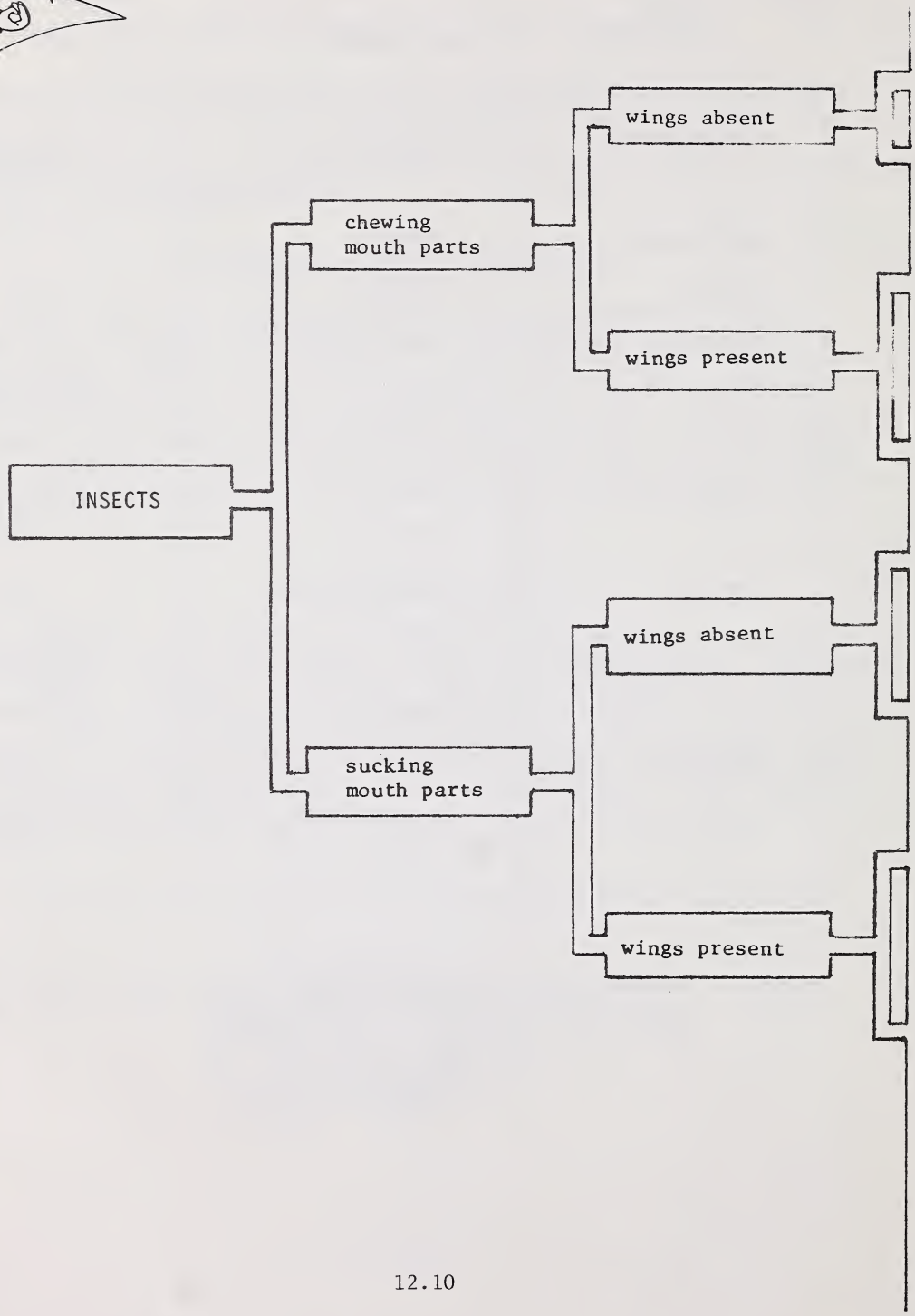


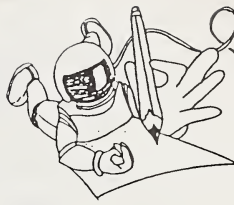
DEVELOPMENTAL STAGES WHEN INSECT IS AN AGRICULTURAL PEST

Insect in Key	Type of Metamorphosis	Pest Stage(s)
grasshopper	simple	nymph/adult
sawfly	complete	larvae
wireworm	complete	larvae
bug	simple	nymph/adult
looper	complete	larvae
beetle	complete	larvae/adult
weevil	complete	adult
thrips	intermediate	adult
aphid	simple	nymph/adult (female)
grub	complete	larvae/adult
mosquitos	complete	adult (female)
biting lice	simple	nymph/adult

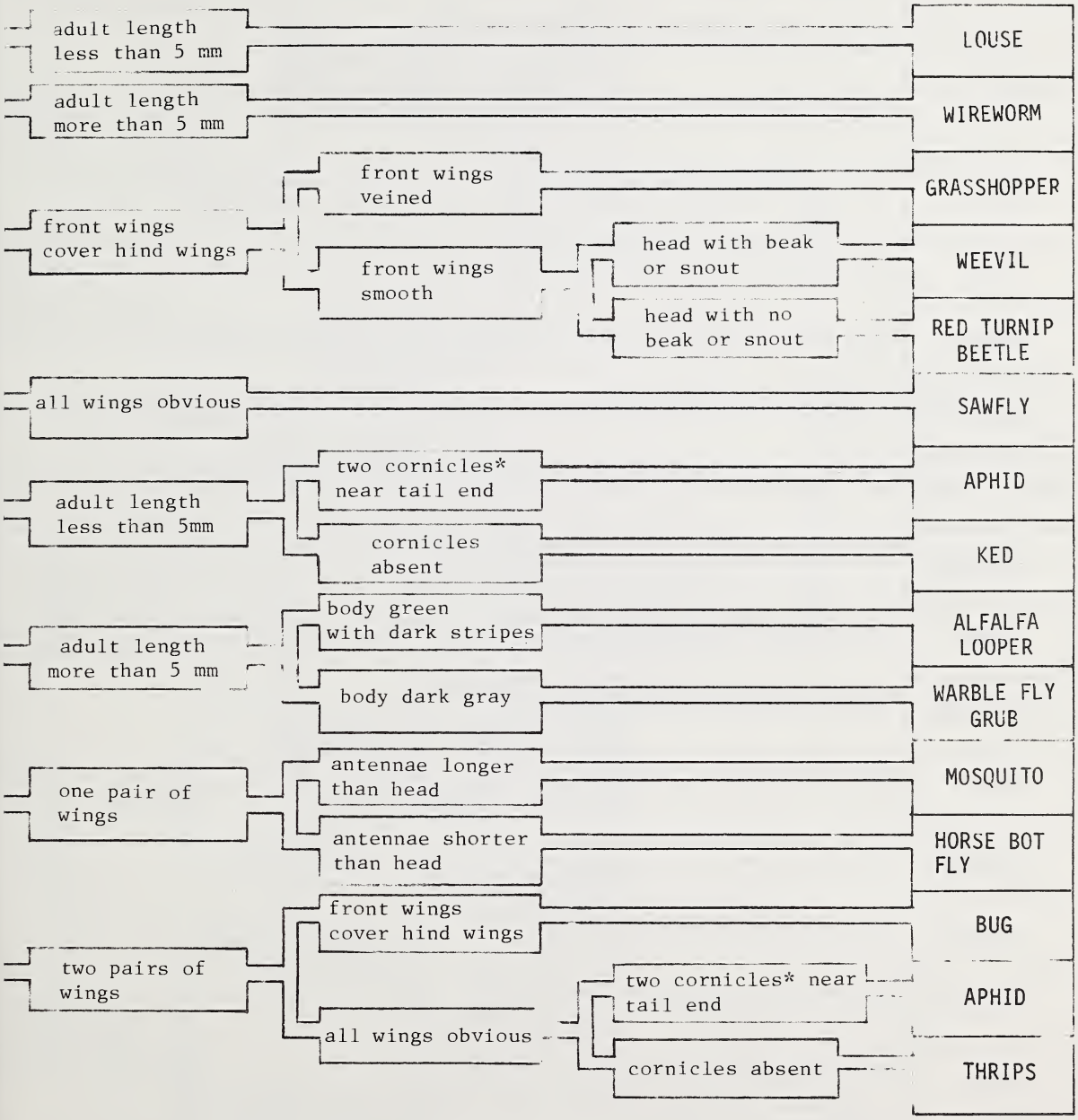
thrips - 4 developmental stages (egg, larva, pupa, adult) but larva resemble adults except for smaller size, lack of wings and paler color.

KEY TO INSECT STRUCTURE, PART A

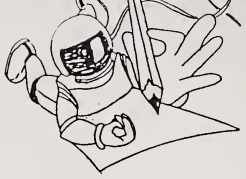




KEY TO INSECT STRUCTURE, PART B



*NOTE: Cornicles are club-shaped structures.



KEY TO FOOD SOURCES, PART A

- CORN
- WHEAT
- RYE
- BARLEY
- OATS
- TIMOTHY
- ALFALFA
- SWEETCLOVER
- RASPBERRY
- TREES
- SUNFLOWER
- CANOLA
- STRAWBERRY
- CABBAGE
- LETTUCE
- RADISH
- TURNIP (rutabaga)
- SUGAR BEET

seeds reddish, elliptical

seeds grayish, cylindrical

seed husks easily removed

seed husks firmly attached

seeds attached directly to main stem

seeds attached to branches of the main stem

stems hollow, shorter than 2 m

stems solid, longer than 2 m

seeds in a disk shaped head

seeds on separate stalks

seeds in a hard, dry shell

seeds in a fleshy berry

seeds or fruit eaten

leaves thick, seagreen or purple

leaves thin, yellow-green

leaves are main food product

root diameter less than 5 cm

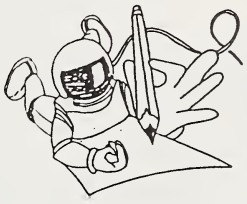
root diameter more than 5 cm

root is main food product

vegetative parts eaten

leaves dull and hairy

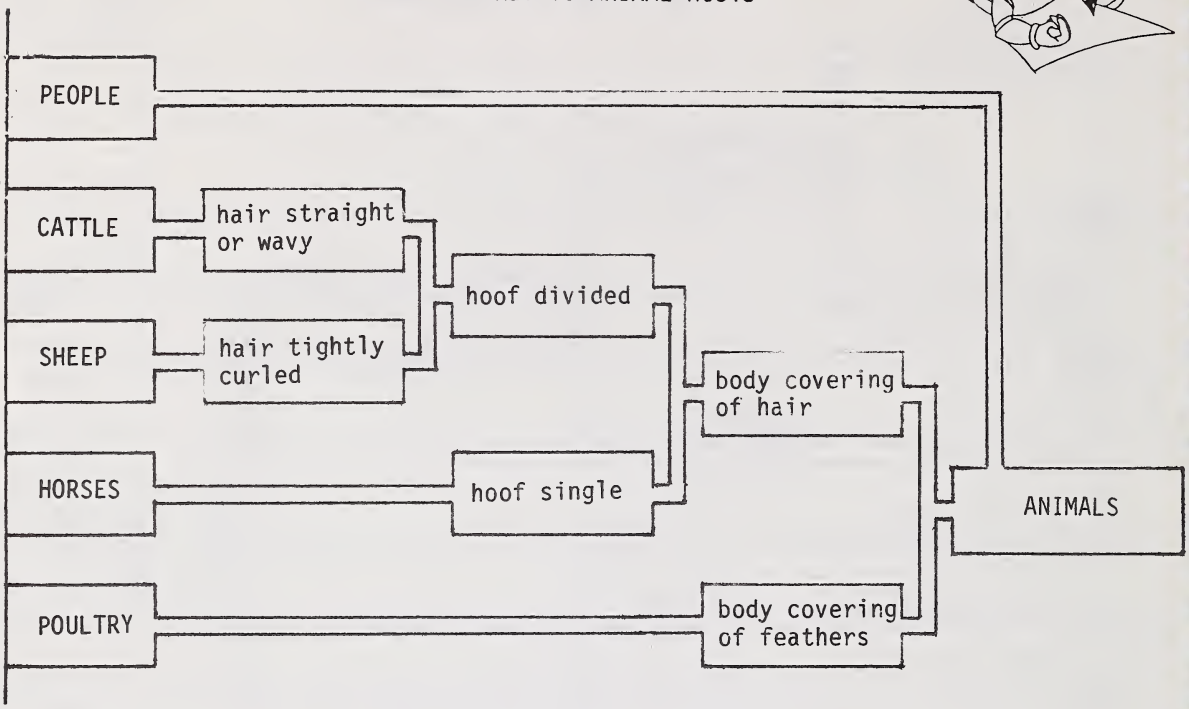
leaves shiny.



KEY TO FOOD SOURCES, PART B

- PLANTS
  - grasses, leaf veins parallel, flowers not showy
    - stems longer than 1.5 m
      - seeds eaten by people or livestock
        - woody stems
          - food for people
        - soft stems
          - food for people
      - seeds very small, fed to livestock
        - purple flowers
          - food for livestock
        - yellow flowers
          - food for livestock
    - stems shorter than 1.5 m
      - seeds eaten by people or livestock
        - woody stems
          - food for people
        - soft stems
          - food for people
      - seeds very small, fed to livestock
        - purple flowers
          - food for livestock
        - yellow flowers
          - food for livestock
  - not a grass, leaf veins netted, flowers showy
    - stems longer than 1.5 m
      - seeds eaten by people or livestock
        - woody stems
          - food for people
        - soft stems
          - food for people
      - seeds very small, fed to livestock
        - purple flowers
          - food for livestock
        - yellow flowers
          - food for livestock
    - stems shorter than 1.5 m
      - seeds eaten by people or livestock
        - woody stems
          - food for people
        - soft stems
          - food for people
      - seeds very small, fed to livestock
        - purple flowers
          - food for livestock
        - yellow flowers
          - food for livestock

KEY TO ANIMAL HOSTS

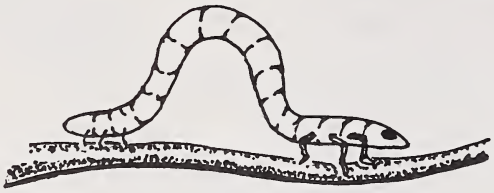


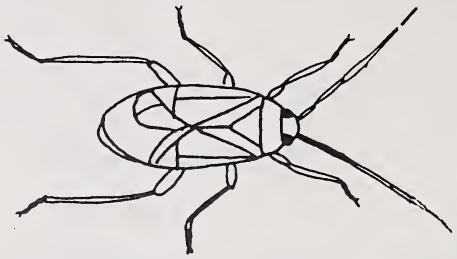
TEACHER'S SHEET 1

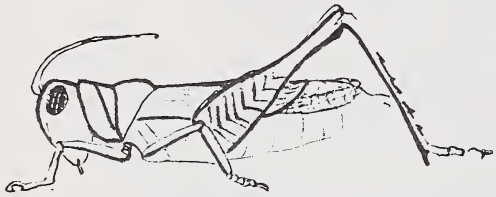
KEY TO THE INSECT INFORMATION SHEETS

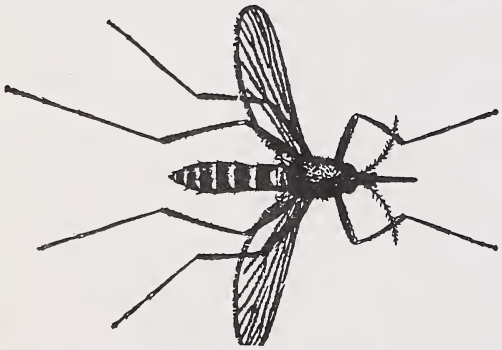
IIS 1	Alfalfa looper
IIS 2	Grasshopper
IIS 3	Plant bug
IIS 4	Mosquito
IIS 5	Ked
IIS 6	Warble fly grub
IIS 7	Horse Bot Fly
IIS 8	Thrips
IIS 9	Aphid
IIS 10	Weevil
IIS 11	Sawfly
IIS 12	Louse
IIS 13	Red turnip beetle
IIS 14	Wireworms

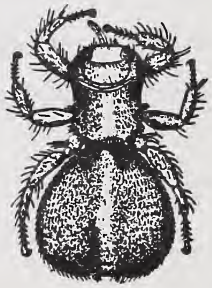
TEACHER'S SHEET 2: UNIDENTIFIED INSECTS

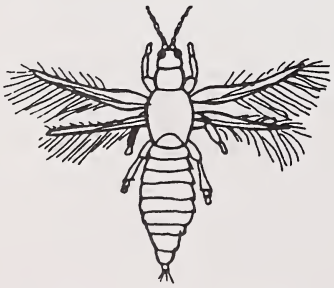




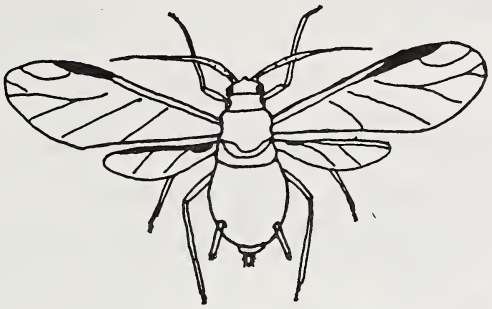


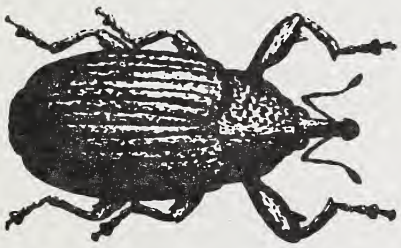


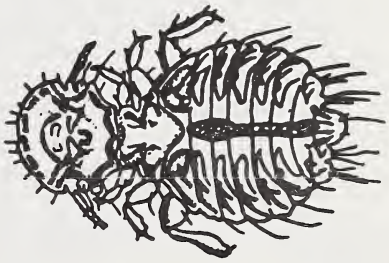


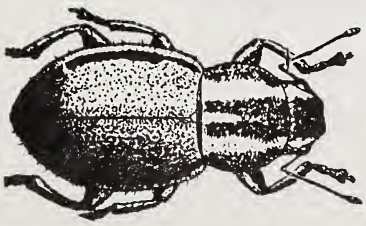


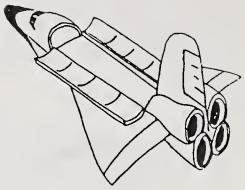
TEACHER'S SHEET 3: UNIDENTIFIED INSECTS











INSECT INFORMATION SHEET 1

Characteristics

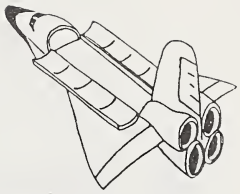
- This pest is the larva of a gray moth.
- It is olive green in colour with a pale head and dark stripes down sides and back.
- Larvae feed for about 4 weeks before attaching themselves to a plant and spinning a woolly cocoon in which to pupate.
- Moves by bringing its hind legs forward, then releasing its front legs and extending its body forward.
- Mature larvae are about 25 mm long.
- Commonly 3 broods a year.
- Overwinters as pupa.

Host

- They suck the sap from alfalfa and canola.
- The plants can normally recover unless severe damage occurs due to a large looper population.

Control

- Normally numbers are limited by natural parasites and predators.
- At lease one virus species in known to be pathogenic.
- Insecticides include chlorpyrifos and methomyl. However, these must be applied at least 21 days before harvest.



INSECT INFORMATION SHEET 2

Characteristics

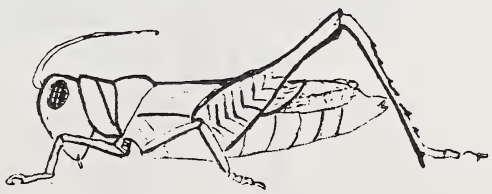
- Over winter as egg, hatch as a nymph, less then 6 mm long.
- Adults and nymphs feed on vegetation.
- Adults 21 - 40 mm long.
- Two pairs of wings: forewings are veined and cover hind wings, hindwings are transparent.

Host

- This pest feeds primarily on native grasses and seeds.
- Causes damage to cereal crops new field margins (damage to grasslands is more evenly distributed.)
- Damage to cereals include leaf stripping and clipping of heads.
- Will chew any plant or plant product when necessary.

Control

- Control by cultivating stubble immediately after harvest to destroy eggs.
- Weed control is important to discourage egg laying.
- Seed early.
- Summerfallow in heavily infested areas.
- Use "trap strips" (rows of cultivated and uncultivated field) in order to concentrate the pest in smaller areas than use insecticide on those areas.
- Predators include the blister beetle (feeds on eggs).
- Pathogens include a fungus disease which leaves corpses clinging to stems.
- Parasites include wasps.
- Insecticides include carbaryl and methadmiophos (do not apply within 10 days of harvest).



INSECT INFORMATION SHEET 3

Characteristics

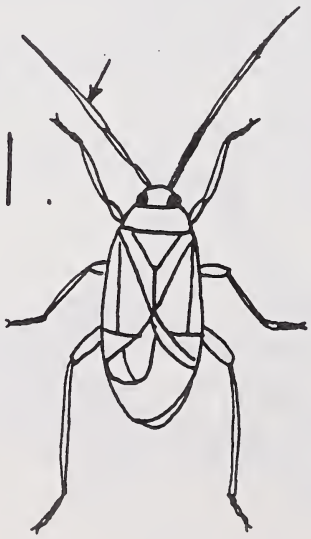
- This family of pests feeds on blossoms in bud stage, flowers, and young seedlings by sucking up plant juices with needlelike mouthpart.
- Two pairs of wings, forewings cover hindwings.

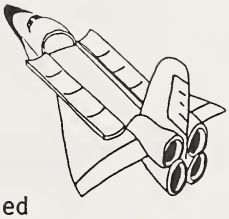
Hosts

- Alfalfa
- Do not affect feed quality, but reduce or prevent seed development.

Control

- Removal of weeds reduces hiding places.
- Predators include the ladybird beetle.
- Spring burning of stubble destroys eggs of many species.
- Chemical control with dimethoate 4E or others.





INSECT INFORMATION SHEET 4

Characteristics

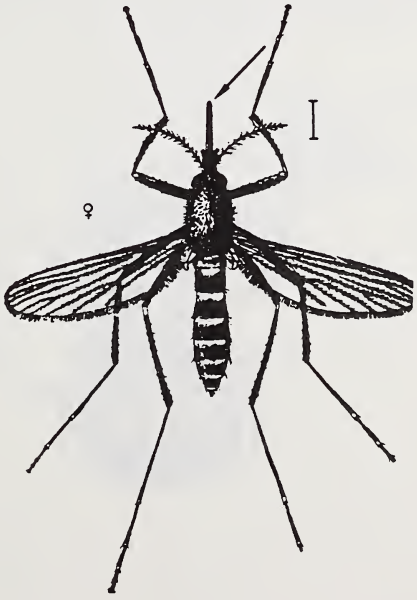
- This pest lays its eggs around water and eggs are hatched underwater.
- One pair of wings.
- Antennae longer than head.

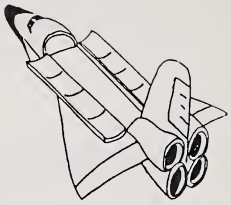
Hosts

- Larvae feed on organic matter in water.
- Female adults search for a blood meal after mating in order for egg to develop - sucks blood from all mammals, including humans.
- Can carry sleeping sickness.

Control

- Control pest through source reduction - drain stagnant waters around home.
- Electrocute using heat source and light.
- Hand killing is also possible, but slow.
- Chemical control at the larva stage only, by spraying stagnant waters.





INSECT INFORMATION SHEET 5

Characteristics

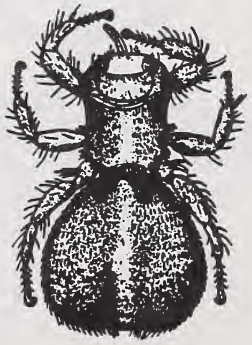
- This pest is a wingless fly which has become adapted to a tick-like existence.
- Adult feeds by piercing skin of the host and sucking its blood.
- Unique in that eggs hatch within uterus of female and the young larva develops to maturity on food secreted by the nutritive glands of the mother.
- Mature larva born after eight days of feeding and growing in the uterus.
- Pupa becomes cemented to the sheep's wool for 22 days then adults emerge.
- Entire life of adult is spent in the fleece of host.

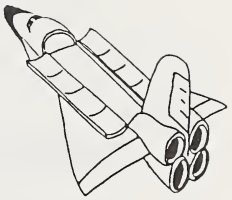
Host

- Goats, sheep, especially the young.
- Insect bites result in a defect in sheepskins known as cockle. Quick recovery occurs if parasite is removed.

Control

- Farmer should feed sheep well, as well fed lambs usually do not support as many pests as underfed lambs.
- Insecticides include diazinon which should be applied in spring after shearing when temperature are at least 10°C.





INSECT INFORMATION SHEET 6

Characteristics

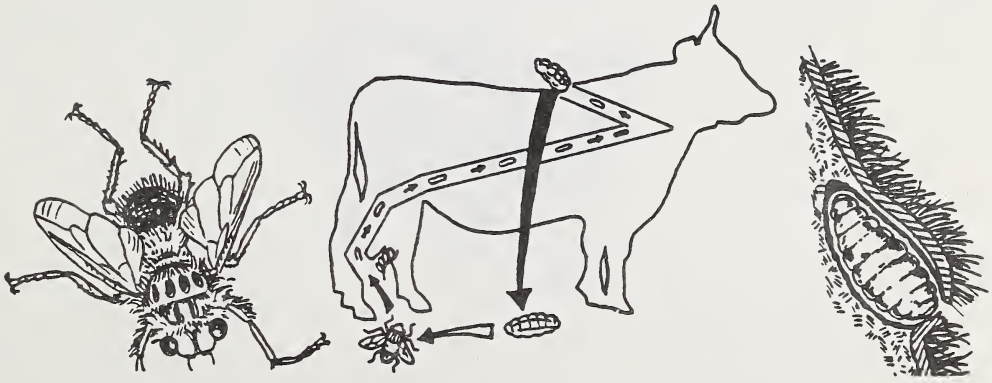
- This pest is the larvae of the warble fly.
- It is dark grey in color with sucking mouth parts.

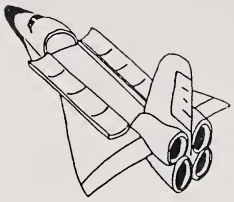
Host

- The adults lays eggs on cattle hairs.
- the larvae hatch and burrow through the skin, wandering through the body until it reaches the back where it cuts a breathing hole.
- remains in cow's body 7 - 9 months.
- larva is dark gray, longer than 5 mm.
- When mature, it squeezes through the hold, falling to ground and pupates in soil to eventually become the warble fly.

Control

- The insecticide rotenone can be rubbed onto warble openings in hide during the spring.
- Systemic insecticides can be applied to calves and adults in the autumn. Cannot treat calves smaller than 62 kg or on milking cows or cattle to be slaughtered within 28 days.





INSECT INFORMATION SHEET 7

Characteristics

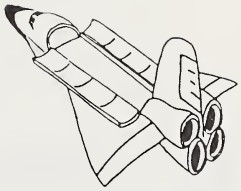
- Can be a serious pest where excess waste material build up.
- Reproduce in manure and are capable of transmitting the stomach worm.
- Feed by sucking blood especially during summer months.
- Antennae shorter than head.
- One pair of wings.
- External parasite.

Hosts

- Horses, cattle, sheep

Control

- Manure, water, and general waste management.
- Keep stalls clean and freshly bedded.
- Good drainage from corrals.
- Remove dead animals to burying ground.
- Treat horse wounds.
- Prevent weed overgrowth to avoid hiding places.



INSECT INFORMATION SHEET 8

Characteristics

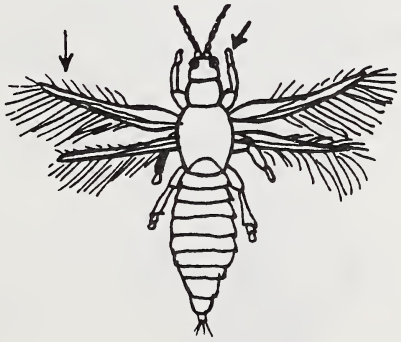
- This pest is small and slender.
- It feeds by rasping or piercing outer plant tissue, and sucking up the juices which escape.
- Damage appears as whitish blotches or streaks on leaves, flower buds, and petals.
- Larva resemble adult even though it undergoes four developmental stages including pupal stage.

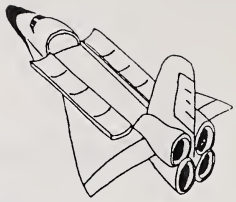
Hosts

- All plants, especially alfalfa and barley
- Predators include the flower bug.

Control

- Under investigation
- Insecticides should not be used when clover crop is in bloom.





INSECT INFORMATION SHEET 9

Characteristics

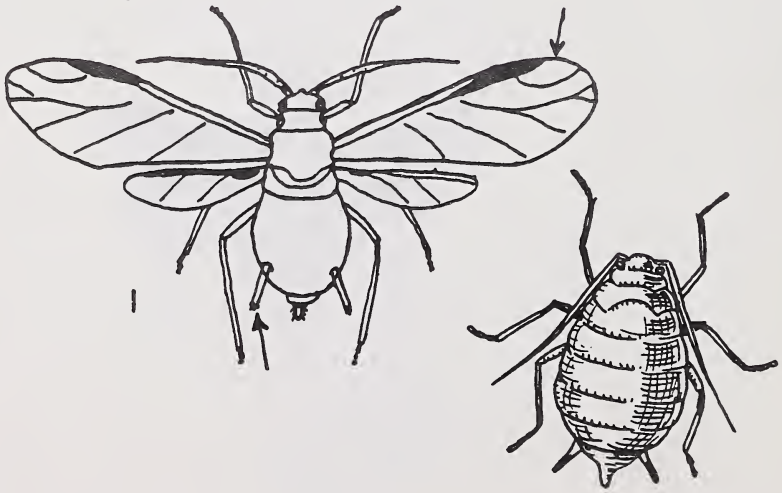
- This pest is small, oval and fragile.
- Adults may be either winged or wingless.
- It has piercing and sucking mouthparts.
- It reproduces both sexually (mating required) or parthogenetically (mating not required).
- Males are not produced until early fall.

Hosts

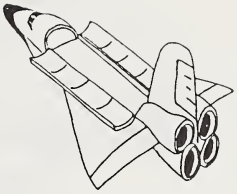
- Injurious to all forms of plant life and may be found on tree bark, stems, leaves, blossoms, fruit and roots.

Control

- Predators include the lacewing.
- Parasites include the braconid wasp.
- The insecticide diazinon can be used on crops and trichlorfon on trees.
- Do not apply diazinon just before harvest.



INSECT INFORMATION SHEET 10



Characteristics

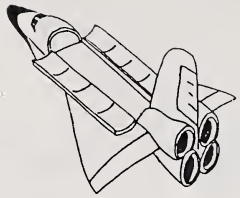
- 4 mm long.
- Dark grey in color.
- Prominent beak.
- 2 pairs of wings; forewings cover hindwings when at rest.

Hosts

- This pest causes defoliation of plants, especially legumes and fruit.
- Chews on alfalfa if no sweet clover is present.

Control

- Control by arranging crop rotations so that new clover fields are as far as possible from old ones.
- Sow clover early (before grain crops) and at proper depth to promote hardy vigorous seedlings.
- Cultivate clover silage and hay fields as soon as crop is removed in order to kill larvae.
- Predators include toads and grubs.
- Pathogens include a fungus disease.
- Insecticides include malathion, diazinon, methoxychlor. Do not use in houses - rather keep doors and windows closed, seal all cracks, and use broom or vacuum cleaner if pest is found in house.
- Insecticides not recommended for tree-infestations.



INSECT INFORMATION SHEET 11

Characteristics

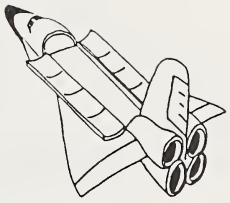
- This pest is wasp-like in appearance.
- Adult do not feed.
- Females lay eggs using saw-like ovipositor.
- Cannibalism occurs among newly hatched larvae.

Host

- Larvae chew on inside of wheat and rye stems - stem is weakened at a point just above ground level resulting in breakage by wind or rain.
- Fallen stems are difficult to harvest.

Control

- Control by swathing infested wheat after kernal moisture drops.
- Rotate crops to barley, oats, alfalfa, etc.
- Delay seeding in spring.
- Summerfallow infested stubble (burning also reduces numbers, but it reduces parasite numbers as well).
- Solid-stemmed resistant varieties of wheat can be tried.
- No insecticides are recommended.
- For infested trees, either handpick the larvae or use acephate.



INSECT INFORMATION SHEET 12

Characteristics

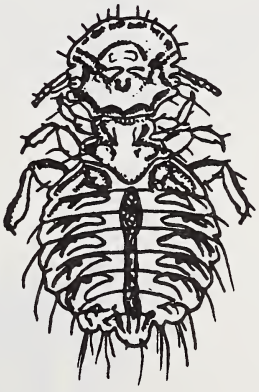
- This pest is small, wingless and flattened.
- It spends its entire life and development on host.

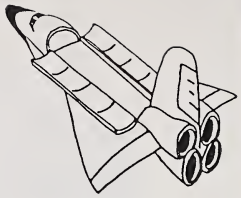
Host

- Major pest of poultry - chews primarily on bits of hair, feather, flakes of skin and other debris on hosts.
- Heavily infested hens appear dopey and listless; egg production decreases significantly.

Control

- Insecticides include malathion dust supplied directly on birds, nicotine sulphate paint on roosts and lindane spray on litter. Do not apply within 7 days of slaughter.





INSECT INFORMATION SHEET 13

Characteristics

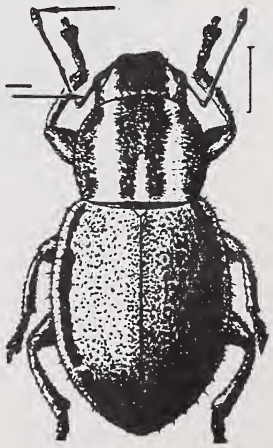
- 7 mm long.
- Adults right red with black patches on head and 3 distinct black lines on the back.
- Overwinter as eggs.
- Larvae black, slow moving, feed at night.
- Pupae bright orange.
- One generation per year.
- Two pairs of wings; forewings are smooth and act as covers for the hindwings when the insect is at rest.

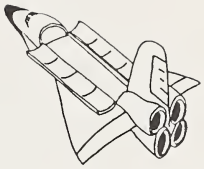
Host

- This pest feeds on potato, cabbage, radish, turnip, rape, and other cruciferous plants.
- The larvae and adults chew on the flowers, seed pods, and foliage.
- Adults are responsible for the greatest damage, especially in seedling canola.

Control

- Cultivate fields after harvest.
- Rotate crops.
- Predators include the fiery hunter.
- Pathogens include microsponidian.
- Insecticides include oziniphos-methyl, carbonfuranete (do not apply within 30 days of harvest.)





INSECT INFORMATION SHEET 14

Characteristics

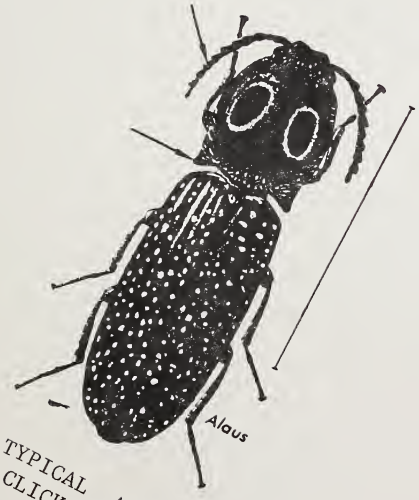
- This pest is the larva of the click beetle.
- Slender, hard bodies, usually yellow, up to 25 mm long.
- May live 5 - 10 years before pupating.
- Always found in soil.
- Chewing mouth parts.

Host

- Roots or germinating seeds of cereal crops and roots of potatoes, sugar beets, corn lettuce and sunflower seeds.
- Can go for 2 years without food if they survive first winter.

Control

- Control by rotating grass with cereal crop.
- Insecticide called lindane can be used as a seed dressing.



TYPICAL ADULT CLICK BEETLE

LARVA

TYPICAL ADULT CLICK BEETLE

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